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ART. XXXI.—DR. JACOB BIGELOW.

DR. JACOB BIGELOW died, at his residence in Boston, on the 10th of January last, near the close of the ninety-second year of his age.

While we would pay the tribute due to his memory as by far the most venerable of American botanists, the last survivor of a school in this country which culminated half a century ago, it should also be remembered that he was even at that time distinguished in other scientific avocations, and that from middle to old age he was among the most eminent of physicians. It is not often that we can contemplate a life so long, so richly various, and so well-rounded as his. He was born in Sudbury, Mass., on the 27th of February, 1787; and his father was the minister of the town. That almost goes without saying, most of our distinguished professional men of his and the preceding generations in New England having been the sons of country ministers. He was graduated at Harvard College in the year 1806, Alexander H. Everett and the late Dr. J. G. Cogswell being among the most notable of his class-mates, all of whom he long survived. He directly took up the study of medicine, was licensed as a practitioner in 1809, and after attending one course of lectures in Philadelphia, took his degree of M.D. at Harvard in the year 1810, and established himself in Boston. There he was a practicing physician for about sixty years, and since the death of his senior, Dr. James Jackson, probably the most eminent one. What turned his attention to botany we know not. He early showed an abiding taste for poetry. His commencement part was a poem, and he delivered a *Φ. B. K.*

poem not long after. At about the same time, however, he gave a course of popular botanical lectures in Boston, in connection with Professor Peck, who must have been installed as Natural History professor at Cambridge while Dr. Bigelow was a medical student. The latter possessed the gift of exposition which Dr. Peck lacked; and it naturally came to pass that Dr. Bigelow repeated this course of lectures alone for a year or two afterward.

In the spring of 1814 he brought out the first edition of his *Florula Bostoniensis*, the book which, mainly in its second edition, has been the manual for New England herborization down to a recent day, or rather to a day which seems to us recent. The original volume, of 268 octavo pages, describes the plants which "have been collected during the two last seasons in the vicinity of Boston, within a circuit of from five to ten miles," exceeding those limits only in the case of Magnolia (from Manchester) and one or two more remarkable plants. We know of no other Flora of the kind which was prepared so quickly and so well. The characters are short diagnoses, and in good part compiled. But the descriptive matter must have been original; and it shows that aptitude for seizing the best points of character or most available distinctions, and of indicating them in few and clear words, which has made this manual so deservedly popular. Similar merits distinguish, on its botanical side, Dr. Bigelow's American Medical Botany, a quarto work which was published, in three parts or volumes, between 1817 and 1821, with colored plates—at that time thought to be very good ones indeed—of the principal medicinal plants of the country. He also brought out an American edition of Sir James Edward Smith's Introduction to Botany; and his botanical knowledge, along with that of the materia medica generally and his classical scholarship, placed him at the head, or at the laboring oar, of the committee which in 1820 formed the American Pharmacopœia. The writer used this volume in his medical-student days, and remembers dimly how the account of minor preparations, coming down to jams and conserves, ended with the classical "Jam satis est mihi."

The second edition of the Florula Bostoniensis, published in 1824, while retaining its modest title, was nearly doubled in size and in the number of plants contained, the whole area of New England being included; and it became the Manual of Botany for the region. What a popular and satisfactory work it was, especially to hundreds of amateur botanists, some still living may testify. The third and last edition, issued in 1840, was a reprint, with various additions and corrections, furnished mainly by those who had learned their botany from the preceding one. This is the last Flora or Manual of this and perhaps

any other country, arranged upon the Linnæan artificial system. Much later in life the author contemplated a revision of the work, brought up to the time, and illustrated by chromo-lithographic plates, such as we have lately seen turned to good account. But after some consideration the project was abandoned. He did not propose himself to undertake the editorial work: for he had long since passed from actual service into the *emeritus* or honorary rank of botanists; and his active professional life, already verging to its close, was diversified or relieved by other avocations. Indeed some of these were taken up very early. He became Rumford Professor of the Applications at Cambridge in 1816, and delivered annual courses of lectures until 1827, when he published the substance of them in a volume entitled Elements of Technology, here coining this apt word. During all this time, and much longer, he was Professor of Materia Medica in the medical school of Harvard University, namely, from 1815 to 1855; for many of these years one of the physicians of the Massachusetts General Hospital; through all of them, and until old age disabled him, a leading physician of Boston. From the year 1847 to 1863 he was President of the American Academy of Arts and Sciences, of which body he was a member for sixty-seven years!

We cannot here refer to Dr. Bigelow's various professional and literary writings. They are not numerous, but are weighty. His treatise on "Nature in Disease," which contains the famous discourse "On Self-limited Disease," is the most important of them; and an address "On the Limits of Education," delivered in the year 1865 before the Massachusetts Institute of Technology, is notable. It has been said of the latter, that never before was the depreciation of classical study or general culture, as a preparation for technical scientific education, undertaken by so ripe a classical scholar or so wide-cultured a man. His many essays in English and Latin verse, some of which have been privately printed, ought to be collected. Dr. Bigelow lived, honored and trusted, to a good old age before infirmities touched his frame, and only toward the close was the brightness of his acute mind dimmed. The candle at length burnt down, the flame flickered awhile in the socket, and the light went out.

The name will abide in botanical nomenclature. First appeared in Rees' Cyclopedia the *Bigelowia* of Smith, founded on the *Adelia* of Michaux. But that is *Forestiera*. Then Sprengel, in 1821, founded a genus *Bigelovia* on a Brazilian plant which he took to be a Rhamnacea; but it is a species of *Casearia*. Again, in 1824, Sprengel gave the name to a part of *Spermacoce*, the *Borreria* of G. Meyer. Then DeCandolle, in 1824, was

proposing a *Bigelowia* on *Solea concolor*, of our own New England, as the Prodromus records, when he found that he had to refer it to *Noisettia*. Lastly, in 1836, DeCandolle bestowed the name of *Bigelowia* upon some golden-flowered Compositæ of the Southern United States, which had borne the name of an Old World genus, *Chrysocoma* (Anglice, Golden-tuft), and he added the complimentary phrase: "A Chrysocoma separatum dicavi cl. J. Bigelow qui floræ Americanæ auream coronam flora Bostoniensi et medica addidit." Although this genus was founded upon only two or three species, it has been vastly extended by the exploration of the western regions of our country, where it forms a conspicuous and characteristic portion of the low shrubby vegetation. More than thirty North American species of *Bigelovia*, besides one of Mexico and two of the Andes of South America, now commemorate our venerable late associate. Most of them were introduced to the genus by the present writer. A. G.

ART. XXXII.—*The Vertebræ of Recent Birds;* by Professor O. C. MARSH.

ONE of the most marked features in the skeleton of modern birds is the form of their vertebræ. This is so peculiar and so constant that it is considered by many anatomists to be the best distinctive character for the class. In no other group of animals known is there an approach to the saddle-shaped articulation of the centra seen in the vertebræ of birds.

Not only do the presacral vertebræ of all existing birds exhibit this structure, but the many extinct forms now known from the whole series of Tertiary deposits have the same articulation. If we knew only these fossil forms, in addition to the existing species of birds, the origin of this peculiar vertebral articulation would perhaps remain a mystery. Most fortunately, however, a few Cretaceous birds have been discovered which throw much light on this point, and virtually explain the difficulty.

In the toothed birds *Ichthyornis* and *Hesperornis*, we have two widely divergent forms. The latter was a huge swimming bird, without wings, and with vertebræ corresponding fully to the modern ornithic type. *Ichthyornis*, on the other hand, was a small bird, with great powers of flight, and with biconcave vertebræ, as in Fishes and Amphibians, and in a few Reptiles. The marked contrast between the shape of the vertebral articulation in these two genera is seen in the figures below, which show a characteristic cervical vertebra in each form.

In the vertebra of *Ichthyornis* shown in figures 1 and 2, it will be seen that the articulation of the centrum is cup-shaped; while in the corresponding vertebra of *Hesperornis*, the ends of the centrum are saddle-shaped, as in ordinary birds. Thus the distinction between the two types in this part of the skeleton is as wide as between *Ichthyornis* and any living bird.

To the evolutionist, who believes that birds are all closely connected genetically, this difference in structure, at first sight, offers a most serious difficulty; since hitherto we have had no hint of a transformation from the one form to the other, and no explanation of the origin of the modern vertebræ of birds.

FIGURE 1.—Twelfth (?) cervical vertebra of *Ichthyornis dispar*, Marsh; front view; twice natural size.

FIGURE 2.—The same vertebra; seen from the left side.

FIGURE 3.—Third cervical vertebra of *Ichthyornis victor*, Marsh; front view; twice natural size.

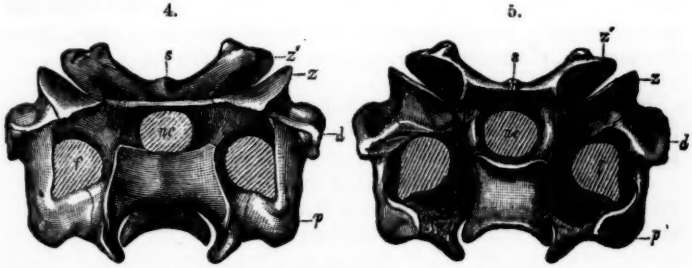


FIGURE 4.—Thirteenth cervical vertebra of *Hesperornis regalis*, Marsh; front view; natural size.

FIGURE 5.—The same vertebra; posterior view.

a. anterior articulation; *d.* diapophysis; *p.* parapophysis; *f.* lateral foramen; *nc.* neural canal; *s.* neural spine; *z.* pre-zygapophysis; *z'.* post-zygapophysis.

In the third cervical vertebra of *Ichthyornis*, however, we catch nature in the act, as it were, of forming a new type; by modifying one form of vertebra into another. Following this hint, the connection between these widely divergent types of structure soon becomes apparent; and the development of the modern style of avian vertebra from the fish-like, biconcave form finds a ready solution. In the anterior articulation of

this vertebra of *Ichthyornis* (figure 3), the surface looks downward and forward, being inclined at an angle of nearly 60° with the axis of the centrum. In vertical section, it is moderately convex, while transversely it is strongly concave; thus presenting a near approach to the saddle-like articulation. None of the other known vertebræ of *Ichthyornis* possess this character.

This highly specialized feature occurs at the first bend of the neck, and greatly facilitates motion in a vertical plane. If, now, we consider for a moment that the dominant motion in the neck of a modern bird is in a vertical plane, we see at once that anything that tends to facilitate this motion would be an advantage, and that the motion itself would tend directly to produce this modification. With biconcave vertebræ, the flexure in any direction is dependent on the elasticity of the fibrous tissue that connects them, as the edges of the cups do not slide over each other. An increasing movement in the neck of *Ichthyornis* in a vertical plane would tend to deflect the upper and lower margins of the circular cup, and to produce a vertical constriction, and at the same time to leave the lateral margins projecting; and this is precisely what we have in the third vertebra.

This modification of the vertebræ would naturally appear first where the neck had most motion, viz: in the anterior cervicals, and gradually would be extended down the neck; and, on to the sacrum, if the same flexure was continued.

Behind the axis, or where the vertical motion prevails, we find in modern birds no exception to the saddle articulation in the whole cervical series.

In the dorsal vertebræ, this cause would be less efficient, since the ribs and neural spines tend to restrict vertical motion, and hence to arrest this modification. This region, then, as might be expected, offers strong confirmatory evidence of the correctness of the above explanation; for here occur, among modern birds, the only true exceptions known in the presacral series to the characteristic saddle-shaped articulation. In *Strigops* and a few other land birds; in the Penguins, the Terns, and some other aquatic birds, one or more vertebræ in the dorsal region are without the saddle-shaped articulation, and are either opisthocœlian, or imperfectly biconcave. In such instances, we can usually, if not always, detect evidence of an arrest of vertical flexure. This may lock together the posterior dorsals by their neural-spines, as in *Strigops*, leaving the power of lateral flexure; or several vertebræ may be coössified, as in *Accipiter* and some other *Raptores*, in which a stiff back is a positive advantage.

In the coössified sacral series of many birds, one or more of the anterior vertebræ have the saddle-shaped articulation. This, however, is no valid objection to the above explanation, since these vertebræ are really dorsals, and have evidently gradually coalesced with the true sacral vertebræ.

In the caudal vertebræ of recent birds we have, in a measure, the original biconcave structure preserved, for here the motion in every direction was much restricted. The caudal vertebræ of these birds, even in the most aberrant forms, are essentially the same, and in the fossil species the articulations at least appear to follow the general rule. In *Pavo* and *Geoccocyx*, the caudal vertebræ exhibit a tendency to a procœlian union. Some other forms also show unimportant modifications of the normal type of caudal articulation, but nothing to suggest a real objection to the explanation now proposed of the origin of the vertebræ characteristic of Birds.

In bringing together the above facts, and others suggested by them, the classification and development of the various forms of vertebræ appear to be somewhat as follows:

(1.) *Biconcave vertebræ* (Fishes and Amphibians); the primitive type; a weak articulation, admitting free, but limited motion. From this form, have been directly derived the other varieties, namely:

(2.) *Plane vertebræ* (Mammals); affording a stronger joint, with motion still restricted.

(3.) *Cup-and-ball vertebræ* (Reptiles); a strong and flexible joint, well fitted for general motion, and evidently produced by it. The vertebræ are procœlian when lateral motion is dominant (Serpents); opisthocœlian with varied motion (Dinosaur cervicals).

(4.) *Saddle vertebræ* (Birds); the highest type; a very strong and free articulation, especially adapted to motion in a vertical plane, and mainly due originally to its predominance.

This subject will be more fully discussed and illustrated by the writer in a future communication.

Yale College, New Haven, Conn., Feb. 25th, 1879.

ART. XXXIII.—*Notice of Gaston de Saporta's Work: The Plants of the World before the Advent of Man;* by LEO LESQUEREUX.

COUNT SAPORTA'S new work entitled "Le Monde des Plantes avant l'apparition de l'Homme," is one of importance, not only for phyto-paleontologists and geologists, but for all who are interested in the history of our planet, in its physical laws, its gradual march of development, and its different phases until it became a fit habitation for the human race.

The first part of the book considers the birth or origin of life and the successive and progressive changes which have modified its forms. The phenomena relating to the existence of living creatures are examined in their applications to organisms from the lowest to the highest in degree of development.

The second chapter reviews the theory of evolution. The author calls it *transformism*. On this subject he rightly remarks, that the theory of evolution does not date from this century; that its origin and history are already old; that the system has been under the critical examination of great minds, who have rightly disparaged some of its extreme tendencies. I quote, in passing, some of the statements of the distinguished author, though they may appear disconnected, in order to show his mode of reasoning on the subject.

"Geology admits great divisions or distinct epochs, and successive formations. But when it comes to the determination of the precise limits of each, to the understanding of the number, the value, or the extent of the stages or subdivisions, the difficulties become inextricable; for generally between two epochs, there appear strata of mixed characters which forcibly excludes all idea of a marked separation between them."

With reference to the remains of plants, he says: "When the details of structure and of geographical distribution, which are recognized in a plant of our time, are in exact analogy with what is known of one or more fossil species of the same genus, it is legitimate to disregard some variations of detail, and to consider the more recent of the two species as a direct continuation of the other. To do otherwise would be to put aside all resources obtained from analogy and induction, or the method itself. Now accepting these premises we may say that there is no tree or shrub in Europe, in North America and in the Canary Islands, which is not found fossil under a specific form more or less intimately allied to one of our time. Nearly always a very ancient type is now represented in its decline, while the more recent appearance of a plant in geological time generally marks its wider extension now."

In the third chapter we have an exposition of the ancient

climates, and not merely that exposition which is indicated by paleontology, but an examination of the causes which have produced similarity of temperature over the whole globe during the first geological periods, and of those under the influence of which the zones of temperature became more and more distinct and narrowed. The discussion turns upon the value of the theories offered on the subject; the comparatively great density of the atmosphere overcharged with vapors, thus increasing its capacity for absorbing and preserving heat; the displacement of the axis of the planet; the internal heat of the globe, etc. All these hypothetical causes are recognized by the author as insufficient to account for the phenomenon. He closes the discussion in admitting as more probable the hypothesis of Blandet, supported by d'Archiac, based upon the nebular theory of Laplace, which refers the early temperature to the still excessive heat of the sun derived from the condensing nebula. After speaking of the sun as derived from the condensing nebula, he says: "This hypothesis may be far from giving a solution of all the facts; but it agrees well with the phenomena of the primitive world, and gives us such a clear reason for its climatic laws, the half veiled days of the Coal period with its transparent nights, the tepid temperature of the polar regions, the original extent of the torrid zones and their gradual subsequent contraction to the present limits, that one would be tempted to admit it, though still repeating in a whisper: Could this be the only cause of such a complex concurrence of phenomena?"*

The sentence here quoted closes the first part of the book; which is an introduction, preparing the way for the exposition of the character of what the author calls the vegetable periods of the primitive and secondary epochs.

In treating the subject, Saporta adopts the natural plan of considering the plants, so far as they are known by their remains, in their order of occurrence from the oldest formation to the more recent. The work follows without interruption the march of the vegetation, from its origin, so far as it has been observed, to the end of the Pliocene, and therefore offers multiplied points of comparison for ascertaining the progress of development of the vegetable types, the modification of their characters, the introduction or first appearance of new types, the destruction or disappearance of old ones, etc.

For Primordial, Paleozoic and Mesozoic times, the examination is limited to what is generally known.† The Primordial

* See on this subject an article of J. S. Gardner, in Nature, Dec. 12, 1878.

† Saporta divides the whole fossil vegetable world in four great epochs, the same as those recognized by Geology. 1. Primordial or Protozoic (Laurentian, Cambrian, Silurian); 2. Paleozoic (Devonian, Carboniferous, Permian); 3. Mesozoic (Triassic, Jurassic, Cretaceous), and 4. Neozoic for the Tertiary.

plants are merely Fucoids. The Silurian are marine species, especially. The author records as terrestrial plants those which have been described from the Cincinnati group. Their nature as representatives of a land vegetation is confirmed by the recent discovery of a splendid fern, *Eopteris Morierei* Sap., near the base of the Middle Silurian of France (the schists of Angiers, zone of the *Calymene Tristani*). This fine fern is placed as the frontispiece of the book—its right place indeed, for the fern, a pinna with large leaflets and perfectly distinct venation, resembles the Neuropterids of the Coal. It plainly proves that the land vegetation of the Middle Silurian, including already plants of so advanced types, must have been varied in its characters. Therefore, according to the law of evolution, it is evidence that a still more ancient land flora existed, probably contemporaneous with the first apparition of the vegetable marine forms.

The Devonian is mostly illustrated by species from Canada, some of which are figured, from Dawson, in Dana's Manual of Geology.

The Carboniferous has its illustrations from European plants, common types, also prevalent in the American Coal Measures.

The Permian flora is considered by Saporta as a mere continuation of that of the Carboniferous, the period being one of transition, as he says; though strictly, on the theory of transformism, all the periods are necessary periods of transition. The Permian has few distinct characters in its vegetation, some Conifers only, *Walchia*, *Ulmannia*, *Gingkophyllum*. This last type is already represented in the Permo-carboniferous of North America by *Saportea*, a sub-genus recently established by Fontaine and White, for the description of leaves very similar to those of the present *Gingko* of Japan.

In the Mesozoic (Mesophytic for the plants), the Trias has few typical forms, and these are merely Ferns and Conifers, whose generic relation, for this last group of plants at least, is with the Permian through *Voltzia* and *Albertia*. The Jurassic, *per contra*, whose flora is known to the author by extended researches, is illustrated in the work by numerous wood-cuts representing species published by himself, Heer, Brongniart and others, all from European specimens. The Jurassic floras of Spitzbergen and Siberia by Heer have afforded an important contribution. No species are mentioned from this country, where the Jurassic is not yet satisfactorily known by its plants. In this flora the *Cycadeæ*, *Protophyllum*, *Zamites* and *Protozamites*, are predominant, along with Ferns and Conifers of the Gingko type, *Baiera* and *Salisburia*.

For the Cretaceous the more important documents are taken from North America and Greenland. Europe has few Cretace-

ous deposits containing plants. In strata of a lower stage, near Beausset, France, remains of a species of fern and of an *Araucaria* have been found, with a fragment of dicotyledonous leaf referred by Saporta to *Magnolia*. The Bohemian Cenomanian has leaves of *Aralia*, *Hymenæa* and *Hedera*, of types recognized, by analogy of characters, in the flora of the Dakota group. From the Senonian of the Hartz are quoted *Abietites*, *Dryophyllum*, *Crednera*, the last two also typically represented in the Dakota group, which, considered by Saporta as referable to the Cenomanian, has five of its species represented as characteristic of the period in the wood-cuts of the work.

In closing the general consideration of the characters of the floras of the three preceding vegetable periods, the author remarks that the second or upper half of the Cretaceous may be viewed as marking by the appearance of dicotyledons the point of departure of the vegetation proper and peculiar to our zone, while the Coal period is that of the whole vegetable kingdom. "From the Cenomanian begins an evolution from which the new tribes progress by multiplication and variation in a constantly increasing proportion."

I shall now consider in more detail some of the points established in the examination of the Tertiary flora, the more important and original part of the book. For I find here a favorable occasion for comparing the essential characters of certain Tertiary groups of this continent, in order to determine thereby some points still in discussion as to their age.

Count Saporta divides the Tertiary into five vegetable periods: Paleocene, Eocene, Oligocene, Miocene and Pliocene. The Paleocene, which corresponds to the Suessonian of Orbigny, is separated from the more recent Cretaceous strata, the Maestricht chalk, by a gap whose width and duration are difficult to ascertain. This period is not yet well known, since the strata containing the vegetable remains of plants have been observed at few localities. To the Paleocene are referred the clay beds of Gelinden in Belgium, the tufaceous deposits of Sezanne in France, and the Suessonian sandstone (*Grès Soissonnais*). The flora of Gelinden is especially composed of species of *Quercineæ*, *Laurineæ*, *Viburnum*, *Hedera* (one species), some *Araliaceæ*, *Menispermeæ*, *Celastrineæ*, *Myrtaceæ*, etc., with some ferns, an *Osmunda* especially. Sezánne has a rich vegetation of large *Juglandeæ*, *Tiliaceæ*, with species of *Magnolia*, *Alnus*, *Salix*, *Virburnum*, *Cornus*, also some *Artocarpeæ*, *Meliaceæ*, *Pterospermeæ*, *Ficus*, *Symplocos* and a *Hedera* (a species of ivy scarcely distinct from the living Irish variety), and a grape. From the upper Paleocene strata have been obtained some *Myricaceæ* and *Araucariæ*, a *Bambusa*, and Palms with flabellate fronds.

In the examination of the remains of plants obtained from

the lower Lignitic strata of the Western territories, the essential characters of a number of species have been recognized as intimately related to, even identical with, those of some species of the flora of Sezanne, and from this referred to the Eocene. Count Saporta considers this question, on p. 221 of his book, as follows: "The Lignitic flora of a vast Tertiary formation of North America, rich in combustible mineral, which occupies an immense area in the new Territories in the West, Colorado, Utah, Wyoming, etc., is not yet sufficiently known. From the materials collected under the direction of the Geological Surveys of the United States, the plants appear referable to three different groups of the Tertiary, the lowest evidently corresponding to our Eocene. The relation of this group with the Paleocene of Europe is evident, notwithstanding the great geographical distance of the localities. This relation is manifested by the close affinity of some of the species of ferns with those of Gelinden and Sezanne, by the presence of Palms of similar characters in both countries, with *Artocarpeæ* and *Moreæ* which recall the *Protoficus* and *Artocarpoides* of Sezanne; species of *Cinnamomum* in the Lower Lignitic which have the facies of those of Gelinden. A *Viburnum*, *V. marginatum*, of Black Buttes, is scarcely distinguishable from the recently discovered *V. vitifolium* of Gelinden. It is the same with some other species; and these affinities are so near and so striking, that they force the idea of a connecting link not merely between the floras but between the regions, at the time when they had respectively the vegetation of which we now study the remains."

Considering merely the affinities mentioned above by the celebrated author, it would seem that the Lower Lignitic flora of this continent should be separated from the Eocene, and referred to the new subdivision established by him, the Paleocene. The flora of the Lower Lignitic, however, is distributed through a great thickness of the formations, and shows points of difference which should not be overlooked in comparing typical affinities, especially when the points of comparison are taken from two far distant countries on two different continents; and still more when the comparison relates to single groups of fossil plants, or vegetable remains obtained from a limited area, like that covered by the deposits of tufa at Sezanne. The lowest strata of the Lignitic at Point of Rocks has indeed a *Viburnum* intimately related, as remarked above by the author, to a species of the Paleocene of Gelinden. But it has also an *Ottelia* (tropical type), which is closely allied to another species of this genus, *O. Parisiensis*, of the Eocene of Paris (Trocadero). This local formation corresponds by its fruits, *Nipadites*, to that of the Sheppey beds of the Eocene of England. Along with *Sequoia longifolia*, which, according to Saporta, recalls a

Cretaceous type, the flora of Point of Rocks has also *Sequoia brevifolia* Heer, represented there by the largest proportion of the specimens. The same species is present in the Miocene flora of Greenland (Atanekerdluk) and also in that of the Baltic.* And still, in this small group of plants of Point of Rocks, twenty-seven, reduced to twenty species in eliminating those described from too poor specimens (as *Populus melanaria*), or those without marked geological affinity, we have *Ficus asarifolia* and *Ficus Dalmatica*, as positively identified so far as identity may be ascertained from fossil leaves, with two species of *d'Ettingshausena*, the first from Bilin, the second from Mount Promina, two localities now referred to the Oligocene (*Tongrian*); *Ficus tiliæfolia*, a Miocene type, easily recognized, and found in the flora of the whole thickness of the Western Tertiary strata, even in the Pliocene of California; a *Diospyros;* a fine *Laurus;* a *Sabal* and a *Fucus*, all of recent types. A *Salvinia* also should be mentioned, as all the species of this genus have as yet been referred to the Miocene.

Yet it is not merely from the identification of a few plants that a relation between the floras of two epochs should be fixed or admitted, but from the general characters of the vegetation representing the climate, and from the general facies resulting from the progress of the vegetation, in passing from types admittedly inferior to others of a more advanced degree of perfection becoming more predominant. Considered in this way, the vegetation of the Lignitic, taken as a whole, indicates the action of a climate of an average temperature far above that of the Cretaceous Dakota Group, and still higher than that of the Paleocene, where the Oaks predominate and there are scarcely any Palms. The prodigious abundance of remains of Palms at Golden, at the Raton especially, is exactly comparable to that of the sandstone of La Sarthe (Upper Eocene), which, says Saporta, recall, by the beauty and the large size of their fronds, the Sabals of Cuba and Florida. If we cannot refer the whole Lignitic flora to that upper stage of the Eocene, if we find in it some typical affinities with the Paleocene, this results from the great thickness of the formation, which, in its four thousand feet of strata, may represent groups of floras related to two or more of the geological divisions established from separate groups of plants, like those which in Europe are referred to the Paleocene and the Eocene. This idea seems confirmed when we compare the diverse elements or groups of plants examined until now from the Lignitic. For if the Black Butte and Point of Rocks deposits are allied by the remains of *Viburnum* and *Ficus* of various species, those of Colorado and

* This Greenland flora, in the opinion of Saporta, Gardner, and other European authors, is closely related to the Eocene flora of Europe.

New Mexico near Trinidad are still more intimately related by a preponderance of Palms, of Ferns of true Eocene character, as recognized by Saporta and Gardner in the identification of Eocene species of England with some of those described from Golden; and also by the presence, at both localities, of *Sequoia* and *Abietites*, of Cretaceous affinity, and of large-leaved *Magnolias* and the *Rhamneæ* closely allied to those of Sezanne.

The Eocene period, as described in Saporta's work, has, at its base, deposits of the coarse limestone of Paris (*Calcaire grossier*) from which have been obtained the large fruits referred to the genus *Nipa* (*Nipadites*), an Indian type intermediate between *Pandaneæ* and the Palms, now inhabiting the flats along the borders of the Ganges. The same fruits, first found at Sheppey, have been discovered also at Paris in the same formation with the species of *Ottelia* mentioned above, along with a few leaves of small Palms, of *Nerium*, *Myrica* and *Zizyphus*.

Saporta has made long and systematic researches on the flora of the gypsum deposits of Aix, which are considered as referable, in their lower part at least, to the Eocene. His celebrated work (Les Etudes), on the vegetation of the Tertiary in the southwest of France, especially considers the fossil remains of that formation. They were discovered, in a very good state of preservation, along the borders of what was once an Eocene lake, whose duration was continued through the Oligocene to the lower Miocene, or Aquitanian. The general characters of this formation are remarkably similar to those of the Green River group of the Western Territories, and in the comparison of the flora also there are indeed some remarkable points of concordance. It is worth while to present in full and for future comparison the description given by Saporta of this group. He says: "This lake or its deposits were for a long time subjected to various changes by natural phenomena. Thermal springs, sometimes sulphurous, sometimes impregnated with carbonate of lime, affording emanations of mephitic gas, then later, volcanic eruptions, followed by flows of basalt, attest the subterranean action which extended even to the water, and brought, at different times, trouble and death to the inhabitants of the lake. Whole shoals of fishes were surprised and buried in the muddy clay of the bottom, a deposit which has faithfully preserved their remains. They are referable to many genera, one of which, *Lebias*, still inhabits fresh water in Sardinia and Northern Africa. Even insects were killed in immense numbers; small and scarcely perceptible flies, mosquitoes, butterflies, libellules, winged ants, bees, gave there to the winds their delicate remains, to be strewn along the shores and buried in the deposit that was soon to be hardened, some of the specimens still preserving traces of their col-

ors. During all this time the flowing water, springs and rivulets, uniting their action to that of the wind and rain, carried to the bottom of the lake fragments of plants of various kinds, especially leaves, branches, flowers and fruits, indeed all the parts naturally torn from the trees and the shrubs growing in the neighborhood along the shore."

For those who have seen specimens of shale of the deposits of Florissant in Colorado, thin laminæ covered with small fragments of plants (their branches, leaves, seeds, flowers, even organs of reproduction, pistils and stamens), along with remains of fishes and insects in immense number, even small feathers, the above description will seem as if dictated by an examination of the deposits of that locality. It applies equally well to those of the Green River station, Elko, the mouth of White River, etc. It is right to remark, however, before looking to the relation in the characters of the plants, that the natural phenomena which have caused the deposits of those remains, have nothing abnormal, are not due to some cataclysm, but are the result of natural atmospheric circumstances. The shales in all the localities named above are in repeated layers of two to five millimeters in thickness, mostly composed of fine sandy materials, the thickest layers of the same nature, but somewhat coarse, all covered upon the upper surface with the various remains mixed together. The thin layers, in repeated superposition, represent therefore annual deposits of materials, mud deposits, laid down in the spring or in the rainy season, hardened in summer, and covered during the process of consolidation by insects, by small floating fragments of plants, etc., mixed with the mud and thrown up by their buoyancy to the surface. The composition indicates a process of consolidation under the influence of heat or summer. Besides the prodigious quantity of insects, the plants, mostly Conifers, are branchlets often deprived of their leaves, like those which, falling to the ground during the winter time, are carried away by water in the spring. A large proportion of the cones are of *Alnus*, and it is well known that these cones are persistent upon the shrubs until the end of the spring. The leaves of some species are extremely numerous, none of them crumpled, folded or rolled, as if driven by currents, but flat, as if they had been imbedded in the muddy surface of the bottom when falling from the trees or shrubs along the border of a lake. In the fish beds of Green River, as they are called, the same phenomenon is observed. One of the richest deposits, eight to ten feet thick, is formed of alternate sandy layers three to five millimeters thick, and it is between the layers that the fishes are found petrified sometimes in prodigious numbers. This evidently shows that under the influence of summer heat, by

evaporation and gradual drainage, the area of the lakes or swamps being gradually diminished by shrinkage, the fishes were driven into deeper places, where finally enclosed they perished in masses. Their remains were later covered by the muddy water of the next overflow in the rainy season. In that immense formation of the Green River group, no trace of effects of volcanic agency is seen. It has been through its whole thickness a series of quiet, lacustrine deposits of calcareous clays, during an incalculable period of time. At Green River station, for example, from the bottom of the river to the top of the highest red buttes, about six hundred feet in thickness, the whole series is a succession of those laminated shales, varying only in their constituent beds, there being white calcareous clay, greenish, sandy, red ferruginous clay, in an uninterrupted succession of thin layers.

Considering the data furnished by the plants in reference to the synchronism of the Green River formation, it is only recently, or since the publication of the Tertiary flora, that we have obtained documents numerous and valuable enough for a future comparison. The collections made in the Green River group in 1847 and 1848, by the corps of the United States Geological Survey, and recently by the explorations under the direction of Princeton College, amount for specimens bearing remains of plants to at least ten thousand, mostly from Florissant. These plants have not yet been determined; part of them, those of the United States Survey only, have been superficially examined and separated in groups for definitive study. Of the whole number of plant remains, nearly one-half are leaves of *Planera*, apparently referable to three different species: *P. Ungeri*, *P. longifolia*, both equally predominant, and a less common one, with veins at a very acute angle of divergence and a facies different from that of the others. *P. Ungeri* is extremely abundant in the Miocene of Europe, especially in the upper strata. It is present in the Tertiary flora of *Greenland*, being found there in connection with or upon the same specimens with a *Pterospermites*, a *Hedera*, and *Sequoia Langsdorffi*. It is not quoted from Alaska and Spitzbergen. In the Gypseous beds of Aix one leaf only is mentioned of this species, from the fish beds of Bonnieux. The author says that it is very rare in this formation, but that it becomes more predominant in the flora of Manosque (Miocene). Fragments of Conifers, mostly Miocene types, *Taxodium*, *Glyptostrobus*, *Sequoia*, etc., abound at Florissant, with leaves of *Myrica*, referable to a dozen species at least, two of which are closely related to *M. Zaccharіensis* and *M. arguta* of the Gypseous beds of Aix. At the same locality have been obtained numerous specimens of a *Populus*, which, though represented by leaves of various sizes and shapes, are

identifiable with P. *Heerii* Sap., of the beds of Aix, where it is very rare. The predominance of *Salvinia*, related to European Miocene types, is also marked in the Green River group, while one species only is described from the beds of Aix, there also very rare. We have also from Florissant a large specimen of a Sabal, which, like *Sabalites major* of the beds of Aix, seems related to the Miocene *Sabal major* of Europe.

If, therefore, we consider the relation of the flora of the Green River group to that of the Gypseous beds of Aix, merely from the number of identical species, it seems to be distant indeed, and more evidently marked with the Miocene. But then, there is against this conclusion the remarkable affinity in the dispersion and fragmentary state of the vegetable remains, and a similar facies of the flora apparent in the predominance of species of *Myrica* and other Southern types, like the leaves described as *Callicoma microphylla*, which, as remarked in the Tertiary Flora, cannot be referred to this Australian genus, but perhaps belong to some peculiar form of *Myrica*. We have also among the vegetable fragments of Florissant, *Diospyros*, *Catalpa*, *Fraxinus*, *Ailanthus*, *Paleocarya Engelhardtia*, *Ulmus*, *Acer*, mostly fruits and flowers, as mentioned by Saporta from the flora of Aix, leaves of peculiar forms of *Quercus*, referable to *Q. salicina* and *Q. antecedens* Sap., and flowers with long stamens, which, lacerated though they are, have some likeness to those of *Bombax*, all from the same flora of Aix.

But it is useless now to look to points of relation. Not only are the specimens from Florissant not yet positively determined, but the locality has, in the whole thickness of its shale, merely vegetable remains of plants growing around a shallow inlet of small area, that of a lake apparently, surrounded for a long period of time by the same kind of shrubs and trees, whose debris, annually strewn and preserved upon the muddy layer of the bottom, does not give a true representation of the general vegetation of the land. The American *Planera aquatica* inhabits only some river swamps of Florida and North Carolina. Its remains, if found in a fossil state, though they might be abundant in a peculiar locality, could not give us the slightest idea as to the facies of the land-flora of these regions. The great difference and variety in the characters of the plants found at other localities of the Green River group, in the deposits of Alkali station, of Elko, the mouth of White River and the cut-off of Green River, show how little we know as yet of the plants of the mighty group, which, like the Gypseous formation of Aix, may represent different geological periods at its lower and its upper parts.

Passing from the lower beds of Aix to the Oligocene (*Tongrian* for its upper part), Saporta sees in its flora the expo-

sition of a more equable and more generally humid climate. The essential types of vegetation recognized in Europe during this period are, for the Conifers, *Libocedrus salicornioides; Chamæcyparis* in two species; some *Sequoiæ*, among them *S. Tournalii* and *S. Coutsiæ; Taxodium distichum miocenicum*, and *Glyptostrobus Europœus.* With these Conifers the author mentions and figures species of *Comptonia*, some of them of typical affinity to the North American *C. asplenifolia*, others to Austro-Asiatic forms; oaks with coriaceous lobate leaves, a Palm, *Sabal major; Aralia Hercules*, species of *Myrica*, *Celastrus*, *Andromeda*, *Diospyros*, *Myrtus*, *Mimosa*, and, as related to present European types, *Betula*, *Carpinus*, *Ostrya*, *Ulmus*, *Acer*, already mentioned in the examination of the Gypseous formation of Aix. From this it is seen that, as the author remarks, this period is the transmission of an older to a new vegetable period. As to localities whose plants are referable to the Oligocene, the author quotes, for France, the deposits in Auvergne; those of Ronzon, of St. Zacharie and St. Jean de Garguier; the Gypseous beds of Gargas in Provence, of Alais, Armissan and Speeback; then Haering in Tyrol, Sotska in Styria, Sagor in Carinthia, and Mont Promina in Dalmatia. The floras of some of these localities were formerly referred either to the Miocene or to the Upper Eocene. The Flysch and Nummulite beds are Oligocene. From all these deposits eight to nine hundred species have been obtained.

The Miocene period is subdivided into two sections or subperiods. The lowest, the Aquitanian, begins with the regression of the Tongrian Sea, and terminates at the invasion of the Molassic, a period which ends with the more recent strata Miopliocene.

The Aquitanian has beds of lignite sometimes very thick. The more important localities where plants of this formation have been discovered are Manosque in Provence; Cadibona, Piedmont; Thorens, Savoy; Paudeze and Monod in Switzerland; Bovey Tracy in England; Coumi in Eubæa; Rhadoboy in Croatia, etc. The flora of both periods of the Miocene is well known, and has been so admirably well studied and described, especially by Heer, that every phytopaleontologist has become acquainted with its essential types. A large number of them are figured in Saporta's book.

The Oligocene types of Conifers, as also those of the dicotyledons, still remaining in the present flora, pass of course through the Miocene. But the climate of this period has a far less degree of uniformity, or the zones a less degree of expansion, and therefore the floras become more diversified, according to the latitude of the localities in which they are observed. Thus the flora of Coumi is marked by a large profusion of meri-

dional forms, though those of the temperate zone are not all excluded. In this flora appears the last European Cycad. Species of *Sabal* are present in all the groups of plants of the Aquitanian. The vegetation of the molasse is still more widely elucidated in the great tertiary flora of Heer. A number of species of *Populus*, *Planera Ungeri*, *Platanus aceroides*, *Liquidambar Europeum*, *Podogonium* species, *Ficus tiliæfolia*, *Myrica Œningensis*, *Comptonia acutiloba*, oaks belonging to the live oaks with semi-persistent leaves, and related to types of Mexico and Louisiana; species of *Tilia*, *Ulmus*, *Celtis*, *Magnolia*, *Liriodendron*, *Vitis*, are the predominant plants of the Upper Miocene period. They are most of them, if not all, recognized in the present vegetation of North America, to which that of the Miocene of Europe has been often compared.

The more important localities where remains of Upper Miocene plants have been discovered in Europe are Salzhausen, Rockenberg, etc., Weteravia; Gunzburg in Bavaria; Bilin in Bohemia; Manat and Mount Charray in France; Œningen in Switzerland; Parschlug and Gleichenberg in Styria; Tokay in Hungary; Vienna in Austria.

In the comparison of the American groups of Tertiary fossil plants, none has been found to agree with those of this period, by analogy of character, but that of Carbon or of the Washakie group, where essentially *Platanus aceroides* or *P. Guillielmæ*, and *Acer trilobatum*, abound, together with species described by Heer from the molasse of Switzerland. That peculiar *Ficus tiliæfolia*, considered as Miocene in Europe, easily recognized by its inequilateral leaves and the coarse and deep venation, abundant as it is in different localities of the Lower Lignitic, has also left its remains at Washakie. It is universally distributed in the ancient floras of this continent.

Saporta's book opens the examination of the Pliocene flora, by an interesting introduction. "The Miocene marks for Europe an era of vegetable splendor, an epoch of quiet temperature without extremes, of beneficial humidity, favoring the highest development of the vegetation upon a continent not yet feeling the change to which it was about to be subjected. The Pliocene period is the declining age of the European flora, the time when the climatic conditions are definitively altered, when the vegetation becomes gradually poor and ceases to gain anything. The progress of the phenomenon is slow, but it moves along an inclined plane on which it never stops. Those ornamental plants, those precious trees, those noble and elegant shrubs which are now carefully trained by artificial culture in European conservatories, were until then inhabitants, of Europe, but left it forever. One by one the ostracised plants take their departure, lingering here and there on the road to

exile. It is this exodus that we should have to describe if we could follow, step by step the march of retrogression, and indicate species by species, the progress and the result of this abandonment of our soil."

The decline in the richness of the vegetation of the Miocene period is described in detail by the author, and its causes are clearly exposed. He considers it (as remarked already) to be essentially the result of a gradual lowering of the temperature, which from its origin at the end of the Eocene, had been in constant progress until now, with casual modifications. It was due to the influence of a phenomenon which has acted upon the whole globe.

The vegetation of the Mio-pliocene has been rarely observed in Europe. From Sengaglia, Italy, Massalongo has described species of the genera *Greuia*, *Acer*, *Fagus*, most of them of present American types. The Conifers are still those of the Molasse, to which *Salisburia adiantoides* is added. *Sassafras*, *Liriodendron*, *Tilia*, *Cercis* are represented there also. Saporta has lately published the flora of the Pliocene tufa of Maximieux, with *Oreodaphne Heerii*, *Laurus Canariensis*, *Persea Caroliniensis*, *Acer opulifolium*, *Nerium oleander*, adding to the specific names the appellation *pliocenica*, all being mere varieties of species living now in the islands or African shores a few degrees south of France, or in the Gulf region of North America. There is also a *Buxus pliocenicus*, a *Torreya*, *Viburnum rugosum*, an *Ilex*, a *Juglans*, and among the ferns, *Woodwardia radicans* and *Adiantum reniforme*. As remarked by Saporta, the Poplar (*Populus alba pliocenica*), the Button Wood, *Platanus*, the Magnolia and the Tulip tree in the Mio-pliocene of Europe were about the same as the species now inhabiting North America; are specifically recognizable, though marked with slight differences. The relation of these species and others named by the author to some of the present time is examined by an exposition of the gradations which have given them their present characters.

The last chapter, entitled "a general insight into the ensemble of the period," cannot be summed up in a few sentences. It relates especially to the phenomena which have contributed, as causative agents or as elements, to the gradual modification of the vegetation from the end of the Mesozoic to the present times. A mass of facts are grouped, compared and discussed, in support of the conclusions, as evidence of the gradual development (evolution) under various local or general influences. As an exemplification of the march of transformism the author figures the leaves of three vegetable types, *Laurus*, *Hedera*, *Nerium*, as they appear in successive periods from the Eocene to the end of the Pliocene.

The remarks on this subject are rendered more interesting and conclusive by their correlative application to the animal kingdom. There is between the modifications of animal and vegetable types a remarkable coincidence which, however, is a matter of course, as animal life depends on the plants. It is well known, for example, that the Giraffe in its African wilderness especially feeds upon Acacia or Gum trees. This kind of plants appears first at the base of the Gypseous beds of Aix, at the end of the Eocene, and there also have been found the bones of Xiphodon, prototype of the Giraffe, which in its present form appears later in the Miocene in its migrating progress from France to Africa. It is at this epoch of the Upper Eocene that mammals make their first appearance in Europe, an advent prepared and predicted by the luxuriance of the vegetation of the Lower Eocene.

It should not be supposed from these cursory remarks, that Saporta's book, "Le Monde des Plantes," is a dry exposition of facts, or, descriptive enumeration of fossil remains, prepared only for the instruction of the paleontologist. Far from this; it is an exposition of the vegetation of our earth, in its gradual modifications from the oldest antiquity to our time, in a series of tableaux as clearly defined by words as they could be by the pencil of a painter. To these tableaux a multiplicity of facts,—some of them new and all instructive—give life and animation; while they are colored by the richness and brilliancy of an admirable style. The book is thus read without fatigue and with increasing interest, from the first page to the last.

Columbus, O., January 23, 1879.

ART. XXXIV.—*Double Stars discovered by Mr. Alvan G. Clark;* by S. W. BURNHAM.

THE double stars discovered by Mr. Alvan G. Clark, of the well-known firm of Alvan Clark & Sons, telescope makers, Cambridgeport, Mass., are for the most part prominent and interesting objects, and, with the exception of Sirius, have not been published, or brought to the attention of astronomers generally. They are nearly all difficult pairs, and such as require for measurement a first-class, if not a large, instrument. All the recorded measures of each star in the following list are given, except of the first. Most of the micrometrical observations are by the Washington observers, and by Baron Dembowski and myself. All of the latter measures have been made at the Dearborn Observatory, Chicago.

The names and places of the stars are as follows:

No.	Star.	R. A. 1880.	Decl. 1880.	Magnitudes
1	Sirius.	$6^h\ 39^m\ 53^s$	$-16°\ 33'$	1 --10
2	W VII, 1131.	7 40 20	+28 59	8 --11
3	ρ Hydræ.	8 42 5	+ 6 17	5 --13
4	L 23271.	12 20 37	+ 0 29	7½--10
5	46 Virginis.	12 54 25	− 2 43	5–6--8–9
6	Arg. (30) 2534.	14 28 45	+30 21	9½--10
7	ε Coronæ.	15 52 37	+27 14	4 --13
8	102 Herculis.	18 3 38	+20 48	5 --12–13
9	γ Lyræ.	18 54 27	+32 31	3 --12
10	P XIX, 257.	19 39 15	+10 29	7½-- 7½
11	ζ Sagittæ.	19 43 39	+18 51	6 -- 6
12	a^2 Capricorni.	20 11 24	−12 55	3 --
13	τ Cygni.	21 10 0	+37 32	5½-- 8
14	78 Pegasi.	23 37 57	+28 42	5 -- 8

No. 1. *Sirius.*

The history of this interesting system is too well known to require more than a brief mention. From periodical irregularities in the observed proper motion of Sirius, Bessel, more than thirty years ago, suspected the existence of a satellite revolving with the large star around their common center of gravity. The theoretical orbit of the disturbing body was calculated by Peters, and a period of fifty years found to satisfy the meridian observations. The suspected companion was looked for by many observers without success. In January, 1862, Mr. Clark placed the 18½-inch object glass, now at the Dearborn Observatory, Chicago, then the largest object glass in the world, in a temporary stand, and turned it upon Sirius. A small star was at once detected almost exactly in the place assigned by theory. Once discovered, it was readily seen and measured with the same instruments with which it had been vainly looked for before. I have seen it repeatedly with my 6-inch Clark refractor; but a steady air is necessary with any moderate aperture, because of the great brilliancy of Sirius, which overpowers the light of the small star, and because of its low altitude in northern latitudes. Probably in the southern hemisphere a good 5-inch object glass would show it satisfactorily. Why it should have remained so long undiscovered, after attention had been called to it, cannot be easily explained. For this discovery, Mr. Clark was awarded the Lalande gold medal.

The companion has been measured every year since 1862, and during the latter portion of the time the observations are very numerous. The last orbit of the theoretical satellite, computed by Auwers, based upon all the available observations of proper motion, gives a period of 49·40 years. From these elements an ephemeris has been calculated for every second or

third year, which is given in the following table, together with some of the actual measures made near the corresponding times. It will be seen that the angular motion of the real star is more rapid than that of the theoretical star, and with a less change in distance, indicating a longer period than fifty years.

Calculated.			Observed.			
1862·0	85°·4	10″·10	1862·2	84°·6	10″·7	Bond.
			62·2	85·0	10·09	Rutherfurd.
			63·2	82·5	10·15	O. Struve.
1865·0	79·9	10·78	1865·2	77·2	10·60	O. Struve.
			65·2	76·8	10·77	Förster.
			65·2	75·0	10·07	Secchi.
1868·0	75·0	11·15	1868·2	70·2	11·25	Vogel.
			68·2	69·5	11·35	Bruhns.
			68·3	71·6	10·95	Engelmann.
			69·2	68·6	11·26	Dunér.
1871·0	70·3	11·20	1871·2	64·0	11·21	Dunér.
			72·2	59·8	11·14	Dunér.
			72·2	67·7	11·55	Newcomb.
1874·0	65·5	10·95	1873·2	65·8	11·12	Hall.
			73·2	60·9	10·65	Dunér.
			73·9	59·4	12·27	Hall.
			74·2	59·0	11·46	Newcomb.
			74·2	58·7	10·99	Holden.
			74·2	57·9	11·10	Hall.
			75·2	57·1	10·81	Dunér.
			75·2	56·6	11·41	Newcomb.
			75·2	56·3	11·08	Hall.
1876·0	62·1	10·59	1876·1	54·9	11·82	Holden.
			76·2	55·2	11·19	Hall.
			77·1	53·1	11·20	Stone.
			77·2	52·8	11·35	Holden.
			77·3	53·4	10·95	Hall.
1878·0	58·4	10·05	78·0	52·4	10·83	Burnham.
			78·1	50·5	11·07	Holden.
			78·2	51·7	10·76	Hall.
			79·1	50·7	10·44	Burnham.
1880·0	54·2	9·33				

The last observed position is the mean result of ten nights' measures made at the Dearborn Observatory in the past two months.

The existence of another satellite has been suggested as an explanation of the variation shown above, but all attempts to find any other body have thus far been unsuccessful.

No. 2.

Discovered in May, 1876, with the 12-inch object glass now at the Vienna Observatory. This very unequal pair is in the neighborhood of Pollux, about 40′ south, and a little following. The only measure is the following:

Burnham.....P=114°·9 D=0″·81 1879·0 1*n*

No. 3. *ρ Hydræ.*

The very minute attendant to this star was detected with the Washington 26-inch refractor. The only measures I am acquainted with are those made with the 18½-inch of the Dearborn Observatory. A mean of three observations is as follows:

Burnham	P=144°·9	D=12″·40	1878·0	3*n*

No. 4. L 23271.

A close and unequal pair discovered May 19, 1876, with the Vienna 12-inch object glass. The following are all the measures:

Hall	P=233°·6	D=0″·85	1876·4	3*n*
Dembowski ..	234·1	0·87	1877·4	2*n*

No. 5. 46 *Virginis.*

Discovered on the same evening as the preceding, and with the same glass. It is a fine pair, and just within the reach of a 6-inch aperture. It has been measured as follows:

Hall	P=158°·9	D=1″·32	1876·4	3*n*
Dembowski ..	148·5	1·21	1877·4	2*n*
Stone	145·7	1·15	1878·2	1*n*
Burnham	151·5	1·48	1878·3	2*n*

The magnitude of the small star is rated 8 by Dembowski, 9·5 by Stone, and 11 by Hall.

In measuring this pair, a very faint companion, about 13th magnitude, was detected.

P=116°·9 D=33″·86 1878·3

No. 6.

A difficult pair of small stars in a low-power field with *σ* Bootis, *np*. It has been measured by Dembowski only, and the following is a mean of two observations:

Dembowski ...	P=139°·8	D=0″·76	1877·0	2*n*

This was also found with the Vienna glass.

No. 7. *ε Coronæ.*

A very difficult and unequal pair discovered May, 1876, with the Washington 26-inch. The companion is an exceedingly minute point of light, even with a large aperture. Mr. Edgecomb, of Hartford, sees it with a 9·4-inch Clark refractor, but this must be regarded as a very remarkable test of acute vision. The following are all the measures:

Hall	P=351°·4	D=2″·17	1876·4	4*n*
Burnham	360·2	1·86	1878·3	2*n*

No. 8. 102 *Herculis.*

A faint companion detected with the 12-inch Clark object glass now in the possession of Dr. Draper. The only measure is:

Burnham	P=46°·9	D=23″·42	1878·4	1*n*

No. 9. *γ Lyræ.* (*OΣ* 544.)

This pair, discovered a number of years since with the 12-inch glass now at the Vienna Observatory, is one of the recently published additions to the Pulkowa Catalogue. It has been measured as follows:

Otto Struve..	P=296°·9	D=13″·79	1868·6	3*n*
Newcomb....	297·8	12·48	1874·5	1–4*n*
Burnham	301·1	12·76	1878·4	2*n*

No. 10. P XIX, 257. (AC=Σ2570=♅ I. 91=S 723.)

This has been known as a wide pair nearly a century. With the Draper 12-inch, the large star in August, 1875, was found to be an excessively close pair. I have measured this with Dearborn Observatory refractor on four nights, as follows:

P=126°·1	....	1877·68
147·4	....	1877·72
147·0	D=0″·26	1878·62
142·0	0·32	1878·70

There is no evidence of change in the 9·5 magnitude star, as will appear from the following observations:

Herschel I.....	P=278°·2	....	1783·6	1*n*
Struve	276·2	D=4″·08	1827·0	3*n*
Mitchel	275·7	3·95	1847·7	1*n*
Secchi	275·3	4·10	1857·6	1*n*
Wilson and Seabroke.	279·9	3·87	1874·1	2*n*
Wilson and Seabroke.	277·8	4·30	1876·7	1*n*
Burnham	276·6	4·16	1878·7	1*n*

No. 11. *ζ Sagittæ.* (AC=Σ2585=♅ II. 30=S*h* 307.)

Discovered as a wide pair in 1781 by Herschel I. It was measured by many observers down to 1875, when the duplicity of the principal star was detected with the same instrument with which the two preceding discoveries were made. My measures of this at the Dearborn Observatory indicate an increase in the distance. I found it obviously less difficult in 1878 than the previous year. The individual measures are as follows:

P=158°·3	D=0″·22	1877·72
157·6	0·24	1877·73
158·1	0·27	1877·77
158·7	0·35	1878·64
155·4	0·35	1878·70

Struve gives the magnitutes, 5·7 and 8·7, of the wide pair. These stars appear to be relatively fixed.

Struve	P=312°·8	D=8°·49	1831·1	7*n*
O. Struve	311·2	8·71	1846·9	7*n*
Wrottesley	311·8	8·77	1854·6	3*n*
Wilson and Seabroke.	311·2	8·8	1873·6	1*n*

No. 12. α^2 *Capricorni.* (AB=H 608.)

Herschel II discovered a 16-magnitude companion to this star and entered it in his second catalogue of double stars. Since that time it has received but little attention from double-star observers. Under favorable conditions a 6-inch refractor will show it fairly. The following are all the measures:

Herschel II	P=141°·2	D=6″ ±	1830±	1*n*
Mitchel	144·1	6·36	1846·7	13*n*
Holden	146·2	....	1874·6	2*n*
Burnham	150·2	7·41	1878·5	3*n*

In November, 1862, with the 18½-inch object glass now at the Dearborn Observatory, Mr. Clark found that this minute companion was itself a close, equal pair. Professor Young was able to see it with the 9·4-inch refractor of the Dartmouth College Observatory when observing at Sherman, Colorado, from an altitude of more than 8,000 feet above the sea level. This, to anyone who has seen this minute pair, is a striking illustration of the importance of getting above the lower atmosphere. The following are all the measures:

Holden	P=57°·6	D=1″·72	1874·6	1*n*
Newcomb	58·6	1·24	1874·6	1*n*
Hall	65·2	1·14	1875·7	1*n*
Hall	63·2	....	1876·7	1*n*
Burnham	61·2	1·06	1878·5	2*n*

No. 13. τ *Cygni.*

This fine pair was discovered in October, 1874, with the 26-inch object glass manufactured for Mr. L. J. McCormick of Chicago. It has already shown rapid angular motion, and is undoubtedly a binary system. It has been carefully and regularly observed by Baron Dembowski. The individual measures are as follows:

P=174·8	D=1·06	1874·90
174·3	1·43	1875·33
171·0	1·33	1875·51
171·5	1·37	1875·67
168·9	1·26	1875·89
163·2	1·26	1876·76
159·8	1·23	1876·82
157·0	1·47	1877·39
157·7	1·25	1877·43
157·5	1·33	1877·59
155·8	1·37	1877·70
155·0	1·21	1877·79
152·5	1·15	1877·84
154·2	1·14	1877·92
152·9	1·17	1877·94

Other measures, with the mean results of Dembowski's observations, are:

Newcomb	P=162°·6	D=1″·10	1874·8	2*n*
Dembowski	174·5	1·24	1875·1	3*n*
Dembowski	170·5	1·32	1875·7	2*n*
Dembowski	161·5	1·24	1876·8	2*n*
Waldo	166·9	1·62	1876·9	2*n*
Hall	160·2	1·03	1776·9	2*n*
Dembowski	155·3	1·26	1877·7	8*n*
Burnham	150·0	1·06	1878·4	1*n*

There is a third extremely faint star:

Newcomb	P=261°·7	D=15″·10	1874·7	1*n*
Hall	260·3	15·68	1876·9	1*n*

No. 14. 78 *Pegasi.*

An unequal, but not very difficult pair, discovered in Nov., 1875, with the 12-inch glass now at the Morrison Observatory, Glasgow, Missouri. Dembowski gives its magnitudes: 5·0 yellow, 8·1 olive. The only measures are:

Dembowski	P=192°·0	D=1″·45	1876·6	4*n*
Burnham	190·8	1·54	1878·8	1*n*

Chicago, March 1, 1879.

ART. XXXV.—*Underground Temperatures on the Comstock Lode;* by JOHN A. CHURCH, Professor of Mining, Ohio State University, Columbus, Ohio.

DURING the summer and fall of 1877, I was engaged in making an extended examination of the mines situated on the Comstock lode in Nevada.* Though investigations of the kind described in this paper were but a subordinate part of the proposed work, and the time given to them necessarily restricted, enough facts were accumulated to show on how vast a scale the heat phenomena of the district are exhibited.

The Comstock mines are not only the only hot ones of note in this country but they appear to be the hottest in the world. The highest mine temperature reported to the British Coal Committee was 106° F., but some of the Cornish mines have shown an air temperature of 100° to 113° F. There the air was hotter than the rock, which is never the case on the Comstock. The hottest water reported in a Welsh mine had a temperature of 125° F. (J. A. Phillips). All of these observations are surpassed by the extraordinary conditions of the Comstock.

*This examination was made in connection with the United States Survey of the Territories west of the 100th meridian, in charge of Lieut. Geo. M. Wheeler, Corps of Engineers, U. S. A.

The rock in the lower levels (1900–2000 feet) of the Comstock mines appears to have a pretty uniform temperature of 130° F. This was the reading obtained for me on several occasions by Mr. Comstock, foreman of the Ophir mine, and about the same temperature was found by Mr. Perrin, foreman of the Chollar Potosi, by Mr. Cosgrove, foreman of the Yellow Jacket (139½° F. and 136° F., 2200 foot level), and by myself in the Crown Point and other mines. These readings were obtained by placing a thermometer in a drill-hole immediately after the hole was finished, and leaving it there for periods varying from ten minutes to half an hour.

The holes in which the thermometers were placed were not sunk especially for this work of testing, but were the ordinary drill-holes made for the purpose of blasting the rock. They varied therefore from about ten inches to three feet in depth, but their shallowness by no means indicates that the results obtained are vitiated by alteration of the conditions through exposure to radiation.

Mining on the Comstock proceeds with extraordinary rapidity. The drifts are advanced steadily at the rate of three, five, and sometimes even eight and ten feet a day, and therefore the ground in which the miners are working is always fresh ground. The drill-hole which is made to-day was covered a week ago by thirty to fifty feet of rock. Very often the holes were in ground which had been exposed only one or two hours, having been sunk immediately after a blast which threw off four or five feet of the rock. The surface which was thus thrown down itself had not been exposed more than twenty-four hours. The high temperature and small flow of air in the heading forbid the supposition that any sensible diminution of heat could have taken place at the bottom of a drill-hole made in material of such low conductivity as rock. These facts give the results as much value as if they had been obtained from holes twenty feet deep.

The surface of the rock exposed to the air of the drift was found on one occasion to be about 123° F., the experiment being made near the "header" or end of the drift. The air itself was found to show considerable uniformity when its temperature was taken under circumstances that were at all similar. In freshly opened ground it varied from 108° to 116° F., and higher temperatures are reported at various points, reaching in fact as high as 123° F. in the 1900 level of the Gould & Curry.

The temperature of the air is subject to more fluctuations than that of the rock, for the simple reason that it is artificially supplied to the mine, and varies according to the distance to which it is carried, the quantity, velocity in the pipe, its initial temperature, and moisture in the drift. The most important

causes of variation are the length of the drift and the presence or absence of water. In general the variation at similar depths is not more than eight degrees. Drifts that do not exceed two or three hundred feet in length are *usually* not above 110° or 112° F. in temperature and often they are below this. But when the length increases to 1200 and 1500 feet the temperature may rise to 116° F. without any other change in the circumstances. But much higher temperatures are encountered in places where the increase cannot be attributed to artificial causes.

These limits are, however, not in the least degree true of the water which enters the drifts from the country rock, and also from the lode rocks. That approaches more nearly 150° F. The vast body of water which has filled the Savage and Hale & Norcross mines for two years, and from which it is safe to say a million tons of water have been pumped within twelve months, gave me a temperature of 154° F. Even after being pumped to the surface through an iron pipe exposed, in the shaft of the Hale & Norcross, to a descending current of fresh air for more than a thousand feet, and then flowing for one or two hundred feet through an open sluice in a drain-tunnel which discharges into a measuring-box, the water in this box was found to have a temperature of no less than 145° F.

But the water varies in temperature in different parts of the lode like the rock and the air. In the East crosscut 2000 foot level, of the Crown Point Mine, which is noted for its extreme heat, a small stream of water, after flowing for nearly one hundred and fifty feet over the bottom of the drift, was found to have a temperature of 157° F. Here the drift was closed so that the water was but little exposed to evaporation. On the contrary, in other places the water is much less hot, but I believe it is always hotter than the air, and in many cases it appears to be hotter than the rock is found to be, except in especially hot spots.

These places of exceptionally high temperature are very numerous throughout the lode and they appear to occupy narrow belts. The East crosscut of the Crown Point 2000 feet level, which was temporarily abandoned and boarded up on account of the heat, gave me an *air* temperature of 150° F., the thermometer being thrust through a crack in the boarding. I felt convinced that at the head of this crosscut the heat must be higher than this, and Mr. Balch, foreman of the mine, informed me that it had been proved so. Another hot spot is in the Imperial Consolidated Mine. Here the Black Dike splits, sending a shoot off to the northeast, and a drift has been run on the two thousand foot level, along the eastern side of this branch dyke. This proved to be a very hot spot indeed. Rock, air and water were all so much above the usual limits of

temperature even in these hot mines that the work of cutting the drift must have been extremely severe. It might not have been accomplished had not the expedient been adopted of boarding or "lagging" up the sides of the drift with a double thickness of plank, breaking joints. This confined the water, which poured down the walls, to a tight chamber, and left the main part of the drift for the men to work in comparative comfort. The lagging remains, and has been carried around into the main drift, which is still in active use. Its joints are calked with tow, and, one of these being stripped for me, the steam from the water immediately poured out and proved to be scalding-hot when tested by the finger. I did not, however, succeed in getting a fair reading of the thermometer, because the crack was too small to admit more than the end of the bulb. The thermometer must have cooled by the evaporation of condensed moisture from its bulb; but, even under these adverse circumstances, the temperature of the steam was taken at 123°.

The Belcher south incline has a hot belt of rock, quite narrow, a short distance above the 1900 station, and in fact similar hot places are found in most of the mines.

It is noticeable that the neighborhood of a dike is apt to be hotter than other portions of the rock. This is the case in the Julia, and in the Imperial, the branch dike is hot, as just mentioned, and the main incline, which is quite near the Black Dike has always been noted for its extreme heat. But nearness to the Black Dike is also a characteristic of most inclined shafts on the lode. Some are west of it; some in it for long distances; others east of it. These inclines do not all exhibit unusual heat and it will be shown farther on that there is a special cause for the exceptions.

Belts of excessively hot ground are not the only noticeable phenomena in these mines. More remarkable still are the belts of unusually *cold* rock. These are fewer in number than the hot belts, but they are also strongly marked. They are always wet, and the water that drips through the crevices of the shattered rock that composes them is noticeably cold to the touch, and cools down the air of the drift. Such a wet, cold belt of rock exists on the eight hundred foot level of the Justice Mine, and there is a very decided change of temperature in passing from one side of it to the other. Lest the low temperature of this spot should be attributed to the water which drains through it from the surface, it is well to add that water drips from the rock in numerous places in these as in most mines, and that usually it is hot, or at least warm.

Other cold belts are found in the mines which are not so cool as that in the Justice, but are perceptibly cooler than the rock at a short distance from them. They complete a well-

linked chain of heat phenomena, extending from rocks that are sensibly cold to the touch, and may not have a temperature above 50° or 60° F., through rocks that have the average atmospheric temperature, and those which are as hot as surface rocks ever become in Nevada, to those which have a temperature of 157° F. There is no reason to doubt that the gradation is quite regular, and the transition from the lower to the higher temperature is made through a much larger series of intermediate steps than the accidental thermometer readings taken show.

The rock is usually dry. Wet portions exist, but these are disposed in comparatively narrow bands parallel with the lode and separated by thick masses of rock; the lode is usually perfectly dry, and never exhibits more than the average leakage of mines. Wet rock is the exception, and dry rock the rule, through the whole lode. In the drifts cut through this hot, dry rock, the walls of the freshly exposed surfaces are painful to the hand, and the air is often filled with dust. The rock is both hard and tough, but, in spite of its strength, it gives an impression of fine porosity to the touch, due probably to its trachytic character. It often has the odor of clay, but not always. It may be slightly adherent, or the impression of dryness upon the tongue may be due to its heat.

The plan of the Yellow Jacket mine is simple and such as to eliminate complications from the single problem of heat absorption by moving currents of air from rock surfaces. From the 1,531 level two parallel winzes are sunk on the lode, inclining with it. They are four hundred and thirteen feet apart, and connected on every lower level by the main north and south drift. The Yellow Jacket is a downcast mine, and the air current passes down the vertical shaft to the 1,119-foot level, thence down the incline to the 1,531 level, through a drift to the south winze, and thence down this winze to the 2,200 level, the bottom of the mine. On its way from the 1,531 it sends a current through the 1,732, 1,935 and 2,040 levels, these currents being reunited in the north winze, which is the upcast. The north winze does not reach to the surface, and no air rises "to day" in the mine, the entire current flowing into the Imperial and Bullion mines, both north of the Yellow Jacket, and both of them exclusively upcast.

Captain Taylor has placed Fahrenheit thermometers of the common kind, with japanned tin cases, at the surface, foot of the vertical shaft (1,119 level), 1,732 south and north winzes, 1,935 north winze, and 2,040 south and north winzes. The south winze is downcast, and the thermometers placed here on the different levels measure the increase of heat in the winze itself, while those which are hung at the north winze measure

the increase of heat, which each "split" of air gains in moving through 413 feet of drift, that being the distance between the winzes. This fortunate arrangement of the ventilating currents presents the most favorable opportunity I have ever observed for studying the problems involved. The thermometers should be replaced with standard instruments, and the air current measured twice a week for a year, in each drift. The result would be the best series of observations obtainable, probably in any American mine, for the comparative shortness of the paths followed by the air, when contrasted with the long drifts of some coal mines, is compensated for by the high temperature of the rocks, and the marked increase of heat in the air. It is also extremely rare to find the conditions of heat absorption so little complicated by artificial additions.

The air-current entering the mine July 2d, 1877, was measured and found to be 18,140 cubic feet. On the 1732 level the "split" or secondary air-current was found to contain 7200 cubic feet, and for the purpose of illustrating the steady flow of heat from the rock, we may reasonably assume that 18,000 cubic feet of air enter the mine every minute, and that this current is divided into three splits of 6000 cubic feet each, which pass from the south winze 413 feet to the north winze, on each of the three levels, 1732, 1935, and 2040. The second of these is out of consideration, from the fact that there is only one thermometer on it, so that no comparison of the initial and final temperatures can be made.

The following tables contain a summary of all the observations which I have been able to obtain. The record is imperfect on account of the destruction of some tally boards, and this has compelled me to omit some records that are preserved, because the corresponding observations in the same drift are wanting. Where the omission takes place, the figures are included in brackets. The figures given are monthly averages, and the final averages refer only to numbers not in brackets.

Only the observations on the 1732 and 2040 foot levels will be made use of, as these are the only ones where a horizontal air current has its temperature measured at two points in its path. Omitting November from the period of the 1700 foot level and December from that of the 2040 foot level, we have for the average of nine months' observations a difference of temperature between the south and north winzes amounting to

1732 foot level	(89·39° − 78·06°)	11·33° F.
2040 " "	(92·30° − 85·35°)	6·95° F.

This difference represents the heat which the air current has absorbed in passing a distance of 413 feet on these levels. In my report made to Lieutenant Wheeler, and also in a paper on this subject presented to the American Institute of Mining

Engineers, these quantities are given as 10·56° F. and 7·87° F., the difference being due to the fact that they were the average of seven instead of nine months' observations.

Yellow Jacket Mine.—Morning Temperature, 6 A. M.

	Surface.	1119 feet.	1732 feet. S. Winze.	1732 feet. N. Winze.	1900 feet. N. Winze.	2040. S. Winze.	2040. N. Winze.
December, 1876,		59·27°	80·23°	92·99°			
January, 1877,		52·55	73·42	86·90		85·35°	93·22°
February, "		49·75	76·99	83·71		86·59	93·99
March, "		53·81	78·13	89·20	90·29°	83·68	94·99
April, "		49·87	77·40	88·13	89·97	85·90	93·77
May, "	(44·48°)	53·77	83·42	90·45	90·99	83·39	93·61
June, "	56·07	57·40	79·39	91·47	93·27	88·26	93·63
July, "			(84·00)		94·07		
August, "			(83·23)		94·50		
September, "	56·67	60·80	81·86	91·67	96·60	88·37	92·13
October, "	46·10	55·13	73·65	90·44	92·07	83·23	88·36
November, "	39·90		(76·53)		88·50	81·27	87·23
December, "	35·84						
January, 1878,	33·39						
February, "	33·93						
March, "	39·84						
April, "	42·37						
May, "	51·10						
Average,	43·52	54·71	78·28	89·48	92·25	85·11	92·33
Time taken,	10 mo's.	9 mo's.	9 mo's.	9 mo's.	9 mo's.	9 mo's.	9 mo's.

Yellow Jacket Mine.—Evening Temperatures, 6 P. M.

	Surface.	1119 feet.	1732 feet. S. Winze.	1732 feet. N. Winze.	1932 feet. N. Winze.	2040 feet. S. Winze.	2040 feet. N. Winze.
December, 1876,		59·20°	80·84°	90·92°			
January, 1877,		50·77	77·82	86·10		83·23°	93·36°
February, "			76·71	84·03		86·82	93·43
March, "		55·52	74·07	88·58	90·29°	86·68	95·00
April, "		52·83	77·57	88·33	89·93	85·87	93·80
May, "	70·47°	61·50	79·42	91·77	93·03	87·16	93·48
June, "	70·33	61·50	79·40	91·77	93·03	88·20	93·73
July, "			(84·16)		94·29		
August, "			(83·42)		94·29		
September, "	69·13	62·76	81·82	91·11	96·67	87·90	92·00
October, "	54·55	57·30	72·99	91·00	92·10	83·32	88·58
November, "	45·43		(77·40)		89·50	81·13	87·23
December, "	39·58						
January, 1878,	38·84						
February, "	37·61						
March, "	44·87						
April, "	52·37						
May, "	60·77						
Average,	53·09	57·67	77·85	89·30	92·57	85·60	92·28
Time taken,	11 mo's.	8 mo's.	9 mo's.	9 mo's.	9 mo's.	9 mo's.	9 mo's.
Average, morning and evening,	48·30	56·19	78·06	89·39	92·41	85·35	92·30

The 1732 level affords us the best evidence that the incessant drain of heat cannot be maintained by supply from a store accumulated in the rock. This drift was probably completed by January 1, 1876, or perhaps some months earlier. It has been constantly in use as an air way, but after this long exposure no diminution in its heating power has been noticed. It has lost the intense heat it had when first opened, but remains at an average temperature of about 90° F.

In other respects I have not observed any circumstances which throw serious doubt upon the thermometer readings. The instruments are not standards, it is true, but they are properly hung on timbers, and usually with ten or twelve inches of wood or air between them and the rock surface. Whenever compared with one of the survey thermometers, hung in the center of the moving air-current, they have not shown a variation of more than one degree. The daily readings are quite uniform, the fluctuations of more than one degree not exceeding twenty-three in a series of about 360 observations. The highest fluctuation noticed is three degrees.

ART. XXXVI.—*United States Geological Survey of the Fortieth Parallel.* Vol. I. *Systematic Geology;* by CLARENCE KING. Reviewed by RAPHAEL PUMPELLY.

THE February number of this Journal contained, in the form of citations, a summary of the results of the Fortieth Parallel Survey in the department of Stratigraphical Geology. The object of the present paper is to present a general review of the more noteworthy results and generalizations, in the other departments.

Quaternary Period.—The Quaternary period of the Cordilleras was contemporaneous with the Glacial and Drift period of the East and of Europe. Its record differs, however, in that no continental glacier ever invaded the Cordillera region to leave, after melting, its immense load of ground-moraine. The climatic conditions which caused the extension of the Scandinavian ice-cap over Northern Europe and of the Greenland ice-cap over Northeastern America produced indeed vast systems of glaciers in the Cordilleras, but they were Alpine ice-streams and as such were localized around the numerous lofty condensing centers and accompanied by the phenomena peculiar to this form of glaciers.

At the east the floods of the Champlain epoch, proceeding from the melting ice, covered the gently graded surface with detritus from the ground-moraine; but the rapid fall of the

Cordillera streams permitted the Glacial floods to form torrents which, aided by the suspended material, cut deep cañons and spread the debris in enormous quantities over the margins of the plains at the mouths of the mountain valleys. An immense amount of erosion was accomplished during the Glacial epoch and there is evidence, to be given below, that it was done during two periods of glacier extension in the Quaternary; during the first and greater the floods cut the deep V-shaped cañons, and during the second the glaciers transformed the upper part of these into U-shaped cañons, and we may add that the second floods deepened the V cañons below the foot of the glacier.

The Great Plains are underlaid by beds which were deposited in a great fresh-water lake. In the southeast these beds dip under the Gulf of Mexico, while near the Rocky Mountains they are 7,000 feet above the Ocean. It is therefore evident that they have been tilted, for otherwise we should have to suppose that there existed a lake whose surface was 7,000 feet above the sea, and for which there was no eastern enclosing wall. Both General G. K. Warren and Mr. King have shown that after the Pliocene such a tilting really took place, so that during Quaternary time this declivity had, as now, free drainage to the Ocean, and was traversed by the rivers flooded from the glaciers.

In the Great Basin the Pliocene—Shoshone—lake was disturbed but not drained off. Its eastern and western edges were depressed 1,500 to 2,000 feet, producing two basins which were occupied by two Quaternary lakes. The eastern one (of which Great Salt Lake is the remnant), extending over 2½ degrees of longitude and 3 degrees of latitude, has been named Lake Bonneville, by Mr. G. K. Gilbert. The western body of water, called by King, Lake Lahontan, occupied about the same absolute range in latitude, with about the same width.

Mr. King infers that the Pliocene lakes were nearly or quite dried up before the Quaternary, because: 1, while the beds contain remnants of only a purely fresh-water fauna, the upper strata sometimes contain deposits of alkaline sulphates and chlorides, that could form in a fresh-water sea only after a nearly complete evaporation; 2, the oldest Quaternary deposits on the sides of the extinct lake basins are subaerial gravels, which were swept by hill-wash and river-floods far out from the parent mountains. During their prime, these inland fresh-water seas were filled to their outlets, Lake Bonneville, over 1,000 feet deep, drained through Red Rock Pass into the Snake and Columbia Rivers. The outlet of Lake Lahontan may have been southward, and the lake must have been over 500 feet deep.

From the fact that the sediments of these lakes are underlaid and overlaid by subaerial gravels, both King and Gilbert infer that there was a very wet period between two dry periods. But our author goes much further, and from the results of a study of the chemistry of the waters, as expressed in the soluble contents of the remaining lakes, and in the natural evaporation products, constructs an ingenious and it would seem a well-founded hypothetical climatic history of the Quaternary period. The argument may be briefly outlined. The now dry shores of the ancient Lake Lahontan are in many places covered, sometimes twenty to sixty feet deep, with a tufaceous deposit, which is often distinctly crystallized and then shows the very characteristic forms of gaylussite—a hydrated carbonate of soda and lime. But chemical analyses show that the soda and water are gone, and that the mineral is now calcite—only the external form being that of gaylussite. In short, we have here an instance of pseudomorphism on a large scale. This pseudomorphous material King calls *Thinolite.* Near Ragtown, Nevada, in a lake which is one of the remnants of Lahontan, and which is presumably fed by springs, the forming of gaylussite can now be seen in operation. It is a dense water very rich in soda carbonate, and when the lake shrinks during the dry season, gaylussite crystals are deposited on the beach and on floating organic substances. Both the facts at this lake and Fritsche's experiments show that gaylussite can form only in the presence of a large excess of carbonate of soda. When the saline water of this lake is diluted during the wet season, the gaylussite is dissolved again.

The thinolite tufa occurs up to an altitude of 470 feet above Pyramid Lake, or within thirty feet of the highest known level of the extinct Lahontan Lake. The inference from this is that the lake must have been long exposed, without an outlet, to concentration by evaporation, and perhaps by contributions from alkaline springs, in order to deposit gaylussite at such an altitude; and, in order to have formed the vast deposits of tufa —originally gaylussite—the lake must have almost wholly evaporated. Now the evaporation of a sea, which, with a depth of 470 feet, was sufficiently saline to deposit gaylussite, would leave its residuary lakes in the condition of saturated solutions; but the fact is that the larger relics of Lahontan, viz: Pyramid and Winnemucca Lakes are sufficiently fresh to support numerous fishes, including one or two of the *Salmonidæ.* It is evident, therefore, that the residuary water of the evaporation of Lahontan, that produced these tufas, must have wholly disappeared. This could only take place by the basin filling to its outlet and remaining at that altitude long enough for its dissolved salts to drain off and for the water to become

thoroughly freshened, after which a rapid evaporation brought about the present condition of things.

This argument places before us what seems unimpeachable evidence of the existence of two periods of great humidity and three of desiccation. These several periods King correlates as follows: the first dry period was at the close of the Pliocene; the two wet periods correspond to the two phases of maximum extension of the glaciers and were contemporaneous with the great ice epoch and the Reindeer ice epoch of Europe; the intermediate dry period corresponds with Newberry's Forest-bed horizon; and the last dry period still continues.

During the intermediate dry time there was probably less vegetation even than now in the Cordilleras and on the Great Plains, and it was probably then, that the greater portion of the lœss of the Missouri and Mississippi valleys was transported to its present position by the west winds as the present writer has shown elsewhere.

The well known fact that the surface of Great Salt Lake is rising—it has risen 11 feet since 1867—has been generally ascribed to the cultivation of the surrounding region. Mr. King shows this to be a wrong inference, for a similar increase has affected all the lakes of the Great Basin. He shows partly from observations connected with the growth of trees on the Sierra, that this is due to a climatic oscillation that began about 1860 and which was the first of its kind and extent that has occurred within at least 250 years. This question of oscillation of climate is full of importance to the populations that are pouring into the regions of the Great Plains during the present moist extreme.

Origin of crystalline schists and granite.—Some space is devoted in this volume to the presentation of original hypotheses explaining the origin of crystalline schists and granitic rocks, of fusion in the interior of the globe, and the cause of varieties in volcanic rocks and the law of succession in eruptions.

Mr. King sees in the crystalline schists beds of sedimentary material in which the change that has taken place has been confined to a re-arrangement of the constituents and the obliteration of the interstitial spaces between the detrital particles. Thus purely silicious beds remain as quartzites, lime beds as marble, and mixed sediments as the various compound crystalline schists. The sediments were penetrated with the original saline solutions of the sea and the metamorphism was effected under great pressure and moderate heat but in the absence of fusion. This is proved by the total absence of the microscopic glass-particles that all volcanic rocks show, and by the abundance of cavities containing fluids and salts that the microscope reveals in almost all metamorphic rocks. There was no fusion,

although it is possible that the temperature of fusion existed but was prevented by the counteracting pressure from producing liquefaction. The hypothesis is summarized thus:

Conditions of metamorphism.—1. There is a horizon below the surface, at a depth which increases with the secular cooling of the globe, at which the heat and pressure are sufficient to produce the chemical activity needed to effect metamorphism. 2. This horizon sinks deeper with the secular cooling. 3. So long as this horizon is within the depth to which sediments are brought down by displacement of the crust and subsidence, so long will crystalline schists be produced. 4. When by secular cooling the horizon of requisite temperature shall have sunk below the possible levels to which sediments can be depressed, then forever afterward the formation of crystalline schists is ended in that segment of the crust.

Out of gneisses thus formed, Mr. King derives the structureless granitic rocks by the action of tangential pressure. During the horizontal compression due to the shrinkage of the globe, there acts also gravitation. Now when the tangential was slight compared with the down-pressing action of gravitation the schists were simply corrugated; but when the tangential was largely in excess, then the structure of the schists was destroyed and the constituent minerals were to a great extent broken up. This is supposed to account for the granitic rocks and all the transitional forms between these and the corresponding gneissoidal varieties.

Genesis and Classification of volcanic rocks.—In regard to the origin of volcanic rocks, Mr. King argues as follows: The temperature of the earth increases from the surface downward; and owing to the rapid conduction in the outer part of the crust, the rate of increase is very rapid at first and then very slow. Pressure also increases from the surface downward, but, owing to the increase in density, the rate of increase is smallest near the surface and more rapid in depth. Now the action of pressure is directly antagonistic to fusion—increase of pressure raising the melting point. It is therefore evident that a comparison of the strength of these two forces—for and against fusion—will show that the resistance offered by pressure to fusion will be least at the point of maximum rate of increase of temperature, and that from that point down the more rapid rate of increase of pressure than of temperature, renders fusion more and more impossible. The position of this point, or *couche*, in which pressure offers least resistance to fusion must be near the surface. The observed rate of increase would indicate that at a depth of about fifty miles the temperature would produce fusion of rock if not prevented by the pressure. Now if by removal of the superincumbent material

the pressure on any given point is diminished at a more rapid rate than that of the cooling of the *couches* below, and if this removal of pressure proceed far enough, fusion must take place; and, being localized, it will form subterranean lakes of molten rock. This *couche* of possible fusion, like all the isothermal and isobaric *couches*, must be parallel to the surface and must rise in ridge-form under mountain ranges. And it is in the active erosion that takes place in mountains that Mr. King finds the means of diminishing the pressure. One of the first objections, that would be advanced to this, would be that erosion does not act with sufficient rapidity. But our author would probably point, and with reason, to the vast accumulations of detrital sediment—thousands of feet thick and covering hundreds or thousands of square miles—which have formed during single geological epochs. During the Cretaceous there accumulated from one to one and one-half miles in thickness of detrital sediment which probably occupies now a larger area than that from which it was eroded, and the following Eocene and Miocene epochs witnessed the enormous outpourings of lava.

In these subterranean lakes of fused rock, are differentiated the varieties of volcanic rocks. Baron Richthofen, after a critical study of volcanic products in Europe, Asia, California and Nevada, proposed a classification of them into propylite, andesite, trachyte, rhyolite and basalt, and stated that wherever several of them occurred in one district the chronological order of their eruption was that in which we have named them. This generalization has been amply corroborated by the 40th Parallel Survey and extended. For Mr. King finds that there is a sufficient persistence of occurrence among the sub-varieties to justify the subdivision of each of Richthofen's "orders" into an acid, a mean and a basic variety (or species) as, for instance, quartz-propylite, hornblende-propylite, augite-propylite, quartz-trachyte, mica-trachyte, augite-trachyte, etc. He goes further, and brings rhyolite and basalt together as the acid and basic extremes of a new order, "neolite."

Now the observations of his survey show that there is a regular order of succession in the eruption of sub-varieties: that when all the varieties of an order appear, the mean was ejected first, then the acid, and last of all the basic. This sequence is explained thus: Fusion, being a function of erosion, is ephemeral, the duration of fluidity being limited by the sinking of the isotherms. Each molten lake must therefore pass through a series of phases which may be stated as follows: 1st, fusion; 2d, crystallization of constituent minerals; 3d, separation, by specific gravity, into a basic, lower *couche* and an acid, upper *couche;* 4th, re-solidification by the reëstablish-

ment of the ante-fusion relation between pressure and temperature.

Now if eruption takes place before the separation, the lava will have a mean composition; as separation takes place the uppermost, or acid, layer is ejected; finally the acid *couche* cools first on account of its higher melting point and higher position, and eruption at this period forces up the basic lava from the *couche*. This is the sequence for King's subdivisions of the different genera; the observed sequence of the genera themselves, i. e. of Richthofen's orders, he explains by supposing them—if we understand him rightly—to represent, from propylite to neolite, each a lower horizon, the depths being determined by the time-intervals; and the differences in character and mean constitution being expressions of the varying of the conditions at increasing depths.

The argument of which this sketch gives only the salient points is undoubtedly, in the writer's opinion, the most consistent hypothesis—the nearest approach to a satisfactory theory—that has been thus far advanced to explain the complicated system of related phenomena under consideration.

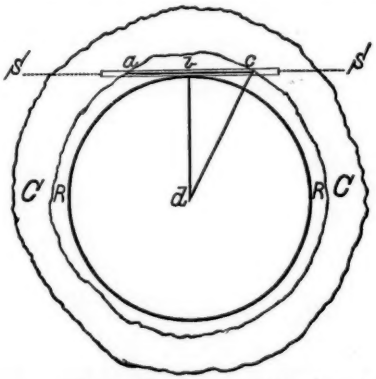
Mountain-building.—In the last chapter there is a review of the conspicuous disturbances of the crust, showing that from the Laurentian to the Quaternary there have been, within the area of the Survey, thirteen periods of mountain-building activity. "In this complicated history . . . . have occurred both upheaval and subsidence as related to the sea-level; plication, always greatest at the western edge of the disturbed area; the formation of folds forty thousand feet from summit to base; the development of faults with at least forty thousand feet of dislocation; the tilting of horizontal regions into broad inclined planes without disturbance, and the division, by complicated fault-systems, of wide areas into numerous separate blocks, of which some are depressed below the level of their adjacent companion blocks." "It is also a general law that those regions which experience elevation without local disturbance are the regions of relatively thin sediment superposed on a comparatively unaccidented Archæan foundation, whereas those which suffer the extremest plication are covered by the thickest deposits overlying and adjacent to the greatest Archaean Mountain ranges." The instances of paroxysmal depression are found to have affected areas immediately after the removal from them of immense thicknesses of material: while the instances of gradual depression occur over areas that were being very heavily loaded with sediment.

ART. XXXVII.—*On a Method of Estimating the Thickness of Young's Reversing Layer;* by W. H. PULSIFER.

A PART of my duties, as a member of the Fort Worth Eclipse party, consisted of the spectroscopic observation of the contacts. I used a telespectroscope combining a four-inch Clark telescope of four feet ten inches focal length, and a ten-prism Browning solar spectroscope. The field included the lines between W. L. 6600 and 6300.

At second contact I observed the reversal of the Fraunhofer lines, and was surprised to find the reversed lines shortened at each end, and occupying but about one-third of the width of the spectrum, while the C line was not shortened and remained in view after the other lines had disappeared. At the moment no explanation of the phenomenon presented itself, but afterward it occurred to me that it was occasioned by the extension of the slit of my spectroscope beyond the reversion layer on each side, and that a measurement of the image of the sun formed on the slit, and of the length of the slit itself, would enable me to estimate the thickness of the reversing layer. Careful measurement showed the diameter of the sun's image on the slit to be $0{\cdot}54^{\text{in.}}$, and the length of the slit $0{\cdot}08^{\text{in.}}$.

In the diagram, C represents the chromosphere, R the reversing layer, S the slit, *a b c* the shortened lines, and *d b* the



radius of the sun. The difference in the length of the lines *d b* and *d c* represents the minimum thickness of the layer, as indicated by the reversed lines observed. Assuming the sun's diameter to be 860,000 miles, and accepting the measurement of the sun's image and of the slit, and the statement that the reversed lines occupied but one-third of the width of the spectrum, the difference in the length of the lines *d b* and *d c* is found to be 524 miles.

ART. XXXVIII.—*The Lower Jaw of Loxolophodon*;* by HENRY F. OSBORN and FRANCIS SPEIR, Jr. With a Plate.

LITTLE has been known hitherto of the real character of the lower jaw of Loxolophodon, a genus which together with Uintatherium forms at present the Sub-order Dinocerata. To the literature which has appeared upon the lower jaw of the Dinocerata, Professor Marsh has contributed in this Journal (III, vol. xi, page 163), a description of a specimen of *Uintatherium* (*Dinoceras*) *laticeps* lacking only the canine-incisor series, and it is safe to say that the general characters of this jaw are also applicable to all the known species of Uintatherium; Professor Cope (Proc. Am. Phil. Soc., Feb. 21, 1873) has given a partial description of the lower jaw of Loxolophodon from fragments which were wanting in the most essential features, leaving a wide gap in our knowledge of this important genus.

The following description is based upon specimens collected in the South Bitter Creek country of Wyoming, about fifteen miles south of Laclede, a station on the old overland road. The horizon is considered by King, Cope and Hayden as belonging to the Bridger Series, which here overlies conformably the Vermillion Creek group. The material comprises two jaws, the first found with a large canine-tusk belongs, without doubt, to *L. cornutus;* the second is smaller, possibly of a female of the same species; together they give basis for a complete study, save of the coronoid process which is lost in both. The accompanying plate figures the former specimen, the incisor-canine series have been placed in position from the latter specimen, in which the alveoli are preserved.

General character of the jaw.—One of the most surprising features of the Dinocerata is the disparity existing between the size and strength of the lower jaw, and the large and formidable head. This is even more marked in Loxolophodon than in Uintatherium, for in general contour the lower jaw is neither long nor deep. In *L. cornutus.* the species in hand, it extends from the well-advanced glenoid cavity barely to the tips of the slender premaxillaries, where it is wholly overhung by the broad and projecting nasals, giving it at once an undersized appearance. The rami are shallow and of equal depth throughout; forward they are wholly in the vertical plane, but behind the molar series they diverge considerably below. The angle of the ramus is not prominent; nearly in a vertical line above this is the condyle. The symphysis is long and narrow. The

* This article is the first of the second series of Paleontological Bulletins upon the Eocene fauna of Wyoming, to be issued from the E. M. Museum of Princeton College.

downward processes below the canine-molar diastema are not strongly marked. The molar series are nearly parallel.

Detailed description.—The ramus swells for the coronoid process close to the lower border, and immediately in front of the rise is the nearly straight molar series. The coronoid rises well up into the temporal fossa, judging from its great thickness below. Slightly above the plane of the molar series are the condyles; they are small, decidedly convex, directed backward and slightly upward with their transverse axes converging. Below these the posterior border narrows and is concave, thickening again into the rough rounded angle which projects slightly back of the condyles. The smooth lower border is nearly straight from the angle to below the first premolar, arching but slightly downward; here it both broadens and deepens and interiorly forms a slightly concave surface extending toward the symphysis, exteriorly it has a process homologous to the pendant process in Uintatherium. This arches gently downward and outward, at an angle probably coincident with the projection of the superior canines; when the jaws are in position it falls not half an inch below the deepest portion of the rami. The downward processes in Loxolophodon are then by no means a distinctive feature of the jaw; on the contrary when compared with *U.* (*D.*) *laticeps*, or when placed side by side with the robust process of the lower jaw of *U. Leidianum* in the E. M. Museum, they show a disparity in size, that seems unaccountable in genera so closely allied.

The dental foramen is large and is situated on a line with the molar series. The mental foramen is double and placed just beneath the canine.

At the chin we find the most peculiar modification of the jaw. The processes, as seen from below, have a more outward than downward direction, forming at the posterior half of the symphysis a broad, slightly concave floor, about six inches in width; below the lateral incisor they disappear, and the chin narrows into a prow-shaped keel. The inner margin of the canine-incisor alveolus is well raised, giving the series the appearance of being placed on the side of the jaw. The alveolus is highest at the canine, and dips downward in front; this would throw the teeth greatly out of the horizontal line, were it not that the dental series increase rapidly in size forward. The teeth are arranged not in a semicircle, but in converging lines two and a half inches apart at the canine and in contact at the median incisor; thus the chin is contracted towards its extremity above as well as below. Between the dental series in front and the high thin borders of the diastema behind is the deeply concave floor of the mouth.

Measurements of the lower jaw.

	M.
Extreme length from infra-condylar depression to symphysis	·295
Depth at last molar	·08
Internal depth of jaw at posterior edge of symphysis	·071
Thickness of jaw at angle	·014
" " at first premolar	·036

The molar series (fig. 2) display three transverse crests, the anterior the most prominent, and forming with the second an open angle, with the apex directed inward; the posterior crest less prominent than the other two, is serrate throughout the series. A cingulum, faint elsewhere, is quite strongly developed at the edges of the third crest. Just beyond the inner apex of the middle crest is a large accessory tubercle which is constant on the true molars and last premolar inclusive.

Beginning the detailed description with the last molar, for it has the characters of all the others in strongest development, we find it is by far the largest of the series. The posterior crest attains its greatest elevation at the center. The middle crest marks two valleys, an anterior and a posterior; the latter dips from a central elevation, corresponding to the highest part of the posterior crest, to the cingulum on either side. Of the two valleys the anterior, which slopes from the apex strongly outward, is narrower but deeper. The anterior crest is nearly horizontal, concave on its forward surface, terminating interiorly in a prominent and exteriorly in a lesser tubercle.

The second molar presents the same characters as the last, but is greatly reduced in size; this disparity is more marked here than it is between any two of the other teeth. The first molar is so much more worn that it fixes three as the number of true molars without doubt.

In the premolar series the anterior crest is relatively more prominent and its terminal tubercles become equal in size. The posterior crest extends more on the inner side of the crown. The third is the only one of the premolars on which the tubercle beyond the apex is found. The second and third premolars have the middle crest comparatively lower, while in the first it rises to form a continuous course with the anterior, giving a crescentic appearance to this portion of the tooth, accompanied by a considerable elevation of the outer marginal tubercle.

The canine incisor series.—Owing to the fragmentary state of the mandible of Loxolophodon found by Professor Cope in the Mammoth Butte beds he was led astray as to the lower incisors. In his pamphlet, "On the Short-Footed Ungulata," (Proc. Am. Phil. Soc., Feb. 21, 1873,) he inferred that "the lower incisors must be regarded as wanting. This is in conformity with the structure of the upper jaw and is rendered probable by the great

reduction of the symphysis of the lower jaw in this species." Professor Marsh subsequently found the specimen of *U.* (*D.*) *laticeps*, already referred to. In this specimen the alveoli for six lower incisors were found, but the teeth themselves were unfortunately wanting; nevertheless the correct dental formula for the Sub-order was established.

The canines and incisors in *L. cornutus* are contiguous and directed upward and forward at such an angle that the two lobes, larger and smaller, are on a line and divide the attrition. They are placed not in a semicircle but in straight converging lines. They decrease in size regularly backward.

The median incisor (fig. 3) consists of an outer convex and inner flat surface. The outer portion is divided by a median valley into two convex lobes; of these, the anterior is placed higher upon the fang, is much the larger and comes to a pointed apex; a section below the apex would be plano-convex, the plane surface being interior. The median valley, dividing the two lobes externally, rises from the cingulum and is cleft near the top by a slight elevation which is possibly homologous to the median crest of the molar series. The posterior lobe is flatter externally, rises lower upon the fang and comes to an obtuse point about two-thirds the height of the anterior. The inner surface of the tooth is nearly flat, with a slightly raised margin; this throughout, except at the apices of the two lobes, is faintly serrate, and is notched at the summit of the median valley. The second incisor (fig. 4) is shorter and more obtuse than the first but larger than the lateral incisor or canine; in it the notches that mark the upper margin are less distinct; opposite the outer convexities the inner surfaces are more concave. In the lateral incisor (fig. 5) the median valley is deeper and the anterior cleft is less marked, while at the head of the valley the upper margin arches inward; the posterior lobe is relatively higher. In the canine the cleft at the head of the valley has disappeared and consequently there is a deep single valley; opposed to this is a more pronounced convexity of the inner surface. The fangs throughout the series are long, stout, arch forward slightly, and decrease in size with the crowns.

Measurements of the Teeth.

	M.
Entire length of molar series,	·165
Length of true molar series,	·094
Fore and aft diameter of last true molar,	·047
Transverse diameter of same,	·036
Height of crown of same,	·030
Fore and aft diameter of first premolar,	·023
Transverse diameter of same,	·019
Height of crown of same,	·022
Length of canine-incisor series,	·140

Measurements of the Teeth.

	M.
Width of median incisor,	·016
Length of same,	·041
Height of crown of same,	·037
Width of external lobe of same,	·026
Width of internal lobe of same,	·015
Length of fang of same,	·060
Width of canine,	·015
Length of same,	·036
Length of fang of same,	·053

The entire dental series show distinctly two types of structure; the molars are modelled after the last true molar which is the most specialized of the series; while the median incisor is the pattern for the canine-incisor series.

Having now detailed the structural peculiarities of the lower jaw there remains to be shown the important bearing that it has in its general form upon many of the still unsettled questions concerning the habits and type-modification of the Loxolophodon and allied genera. The undersized downward processes are of value in so far as they fully confirm Loxolophodon as independent genus from Uintatherium; they also show that the robust processes of Uintatherium did not have for their object the protection of the upper tusks; otherwise they throw no new light upon the subject at issue. It is around the canine-incisor series that our interest chiefly centers. Immediately the question arises how did these teeth, worn at their tips, strongly directed forward and fixed with stout fangs, meet the upper jaw and how were they of use in feeding. This it seems to us, finds a ready answer when we turn our attention to the premaxillary bones; of these Professor Cope (Proc. Am. Phil. Soc., Feb. 21st, 1873) says: "the premaxillaries do not enclose the very large foramen incisivum in front and are therefore deeply furcate." A careful examination of a fine specimen in the Princeton Museum does not wholly confirm this statement, if we understand it aright. In the posterior half, the premaxillaries are united by a bony plate, and as the inner margin of the anterior half is not a rough line indicating muscular attachment but an irregularly broken edge, it is reasonable to infer that between these bones there was a thin plate of true cartilage in which ossification was certainly advancing at the sides if it never reached the center. These edentulous premaxillaries probably supported a callous pad; if so it is singular that this modification so characteristic of the Ruminants should be found in this formidable aberrant type, especially as it has strong perissodactyle affinities. Now as regards the process of feeding, it is certain that, setting aside the short neck and elevated shoulders, the extreme protrusion of the nasals would not per-

mit of the action of close cropping, and this leaves the only alternative that the animal browsed from the tall reeds and undergrowth which accompanied a moist and tropical climate. These conjectures, if established by more extended research, are valuable in connection with the dispute regarding the proboscidean characters of the sub-order, which occupied many pages in vol. vii of the American Naturalist, for they do away with the necessity for a proboscis, pointing rather to a powerful prehensile upper lip. It will be understood, however, that no more validity is claimed for them than that of mere hypothesis, to be strengthened or broken down by further evidence.

Explanation of plate.—Fig. 1, left lower ramus of *L. cornutus*. Fig. 2, molar series of same. Fig. 3, median incisor. Fig. 4, second incisor. Fig. 5, lateral incisor. Fig. 6, canine. The ramus is drawn one-third natural size; the remaining figures are two-thirds natural size.

ART. XXXIX.—*Notice of recent Additions to the Marine Fauna of the eastern coast of North America, No.* 4; by A. E. VERRILL. *Brief Contributions to Zoology from the Museum of Yale College.* No. XLI.

IN the following notice there will be found descriptions of new species of Hydroids, belonging to the *Plumularidæ*, referred to in the preceding number, but from which they were omitted, for lack of space. These and other species herein named, as well as those described in the last number, form part of the extensive collections of marine Invertebrata, belonging to the U. S. Commission of Fish and Fisheries, which have been entrusted to me for examination and description, by the Commissioner, Professor S. F. Baird. In the present notice, there are also included certain species which were collected during several special dredging expeditions, undertaken by the author, with Professor S. I. Smith and others, in 1864, 1865, 1868, 1870, previous to the organization of the Fish Commission.

HYDROIDA.

Cladocarpus Pourtalesii, sp. nov.

A large species, forming a tall, unbranched, secund plume. Hydrocaulus stout, compound, rough; the component tubes run in an irregular subspiral course, and each bears two rows of nematothecæ. The pinnæ are very numerous, about an inch long, and arise alternately, in one line, along the front of the stem and curve outward and upward. Hydrothecæ about twice as long as broad, only slightly enlarged toward the aperture, which has a smooth even margin; intrathecal septum

conspicuous, the free edge curled upward. Lateral nematothecæ short, broad, rising but slightly above the margin of the hydrothecæ; median nematothecæ short, adnate, except close to the end, rather more than one-third as long as the hydrothecæ. The gonothecæ, which are borne on short, jointed, branches arising from the base of the pinnæ, are subcalceoliform, when seen in a side-view, but in a front-view obovate, narrowing to a slender base; aperture lunate, near the end, on one side, the lower lip sunken or incurved. There are one to five gonothecæ on each supporting branch. Color, light yellowish.

Height of largest specimen, 200^{mm}; length of naked part of stem, 40^{mm}; length of pinnæ, 18 to 22^{mm}; diameter of stem, 1·5^{mm}.

S. W from Cape Sable, N. S., 112–115 fathoms, gravel, 1877, U. S. F. Com. Also taken on Banquereau, N. S., in 300 fathoms, by the crew of the schooner "Magic," Capt. W. Thompson.

Cladocarpus cornutus, sp. nov.

Hydroid subpinnately branched, rather rigid, with compound stem. The few branches (four in one example) diverge at a wide angle, and are like the main stem. Pinnæ not crowded, spreading outward abruptly, and somewhat bent backward, about a third of an inch long. Hydrothecæ large, somewhat compressed, adnate to the stem, somewhat triangular or obconic in a side view, expanding from base to rim, with a conspicuous median keel or ridge along the front, which rises into a prominent, lanceolate, acute lobe projecting considerably beyond the lateral borders, which are divided into about five, often unequal, obtuse, subangular lobes, a small incurved lobe being situated each side of the base of the large median lobe; intrathecal septum narrow, situated near the bottom of the hydrothecæ. Lateral nematothecæ elongated, the ends free, spreading outward laterally, margin crenulated; median nematothecæ short, narrow, tapering, directed outward, with the mouth very oblique, and margin crenulated, free for about half their length, and not extending so far as the middle of the hydrotheca. Each joint of the pinnæ is divided internally into five or six compartments by transverse septa. Gonothecæ swollen, obovate, borne on the mid-rib of the main stem and principal branches, at the bases of short, jointed, special protective branchlets, either simple or forked, many of which have a single hydrotheca, of the ordinary form, on the last joint, but only nematothecæ on the others. Dark horn-color.

Height, 70^{mm}; length of longest branch, 20^{mm}; length of longest pinnæ, 8 to 9^{mm}.

Off Sable Island, N. S., on Banquereau, in about 200 fathoms. Obtained by the crew of the schooner "Marion," Capt. J. W. Collins, Sept. 12, 1878, and preserved by Mr. Newcomb.

Cladocarpus speciosus, sp. nov.

Our single specimen is small, unbranched, without gonophores. Stem compound. Pinnæ slender, not crowded, spreading at a wide angle. Hydrothecæ rather short, slightly campanulate, in a side view the breadth of the aperture is equal to two-thirds the depth; a faint median ridge on the front; the margin is divided rather regularly into about eleven or thirteen, moderate sized, subacute teeth, the outer median tooth, and that next to it, on each side, a little longer than the rest; intrathecal septum well-developed, near the bottom; lateral nematothecæ short, swollen in the middle, narrowed to the aperture, margin crenulated; median nematothecæ short, adnate, except at the end, where the oblique aperture faces the hydrotheca, margin crenulated.

Height, 26^{mm}; length of pinnæ, 10^{mm}.

Banquereau, off Sable Island, N. S., in about 200 fathoms, with the preceding species.

Mollusca.

Cingula Jan-Mayeni nob.

Rissoa Jan-Mayeni Friele, Nyt Mag. for Naturvidensk., 1877, Jan-Mayen Mollusca, (author's copies, p. 4, figs. 4 a, b.)

Several specimens of this species were sent to me by Mr. J. F. Whiteaves, who dredged them in 1873, in the Gulf of St. Lawrence, 200 fathoms, mud. It is recorded as from 70 to 300 fathoms, off Greenland, by Friele. It is allied to *C. arenaria* Migh. (=*R. scrobiculatata* Möll.) and to *C. carinata* Mighels, but is a larger and stouter species than either of these, with stronger sculpture and more angular and shouldered whorls. The color is dark chestnut-brown. There are, in our specimens, four strong revolving ridges on the last whorl; the upper one nodulous; the lowest, stout, basal; about fourteen transverse subsutural costæ, extend to and join the first revolving ridge, giving rise to the small tubercles. On the spire only two spiral lines are visible. Length, 4^{mm}; breadth, 2·5^{mm}.

Cingula areolata nob.

Turritella areolata Stimp., Shells of New England, p. 35, 1851.

This species, which has long been lost sight of, and even omitted from Binney's Gould, I have recently rediscovered among small shells dredged at Mt. Desert Island, coast of Maine, about 1860, by the late Professor Wm. C. Cleveland, and also among the shells from the Gulf of St. Lawrence, sent by Mr. J. F. Whiteaves, who dredged it in ninety-six fathoms, in Trinity Bay. It is allied to *C. carinata* Mighels, but is a more delicate, longer, and more pointed shell, translucent, and nearly

white in color, and has a smooth base. It somewhat resembles a minute *Scalaria*. The six whorls are well-rounded, with deep sutures; the last whorl has four or five delicate revolving ridges, around the middle, but none on the base; the numerous and regular subsutural ribs cross two or more of the revolving ridges. The aperture is slightly angular and effuse in front, or sometimes even slightly notched. The inner lip is scarcely continuous posteriorly, or represented only by a very thin deposit on the body-whorl; no umbilicus. An examination of the soft parts and of the dentition shows that this is a genuine *Rissoa*, (as understood by Jeffreys and others, in the wider sense). But it seems to me better to adopt the name *Cingula*, as restricted by Gould, in 1841, for those species, mostly northern, which lack the opercular cirrus, and which, also, usually have thin shells, with no distinct rib on the outer lip. To this group belong nearly all our other New England species, viz: *C. aculeus* Gld., *C. multilineata* (St.), *C. castanea* (Möll.), *C. arenaria* M. (=*R. exarata* St.), *C. carinata* M., *C. latior* M., *C. globulus* (Möll.). No true *Rissoa* has yet been found on the Northeastern coast of America.

Cingula castanea nob., (=*Rissoa castanea* Möller).

This species I have dredged at Eastport, Me. (1864). Professor Cleveland took it at Mt. Desert, Me.; and Mr. Whiteaves in the Gulf of St. Lawrence. It is sometimes white.

Acirsa costulata nob., (=*Turritella costulata* Mighels, 1841).

The species, very well described and figured by Mighels, is undoubtedly identical with *A. borealis* Beck, MSS., and *A. Eschrichtii* (Möll. 1842) of authors. The name given by Mighels appears to have priority of publication. It is not uncommon off the coast of Maine, in 10 to 90 fathoms.

Leptochiton alveolus (Sars) Lovén.

Mr. W. H. Dall has detected this species among specimens dredged in the Gulf of Maine, in 150 fathoms, by Dr. A. S. Packard, for the U. S. Fish Commission, on the "Bache," in 1872. He also informs me that he has received it from the Gulf of St. Lawrence, 220 fath., (Coll. Whiteaves).

Leptochiton cancellatus (Sby.) H. & A. Adams.

Mr. Dall has identified, as probably of this species, an immature specimen dredged by me, in 1877, off Halifax, N. S., in 95 fath., while on the U. S. Fish Commission.

Doris repanda Alder and Hancock, (=*D. planulata* Stimpson).

A critical examination of the dentition of this species shows that the American specimens are perfectly identical with the European.

Acanthodoris ornata Verrill, sp. nov.

Length about 1 inch, or 25mm; breadth 8mm. Body elongated, high at the sides, somewhat oblong; but narrower and obtusely rounded behind, extending much beyond the mantle; mantle much smaller than foot, broadly rounded in front, and expanded into rounded antero-lateral angles, narrowed and often incurved in middle and again expanded opposite the gills, covered with small, conical papillæ, except on a smooth area on the middle of the back, extending from the gills to the tentacles. Frontal veil broad, angular, with four distinct, but small, papilliform processes, two directed forward and two at the prominent outer angles. Dorsal tentacles long, slender, tapered at the end, length, nearly equal to breadth of body (6mm), the lower half smooth, the distal half with about sixteen strong lamellæ, and a terminal rounded papilla; sheaths rudimentary, with very small papillæ. Gills eight, large, broad, in expansion exceeding the breadth of the body, bipinnate, finely divided, the two posterior ones smaller, all united by a basal web; anal area smooth. Color, translucent yellowish flesh-color, specked with yellow and brown; bases of papillæ surrounded by brown; dorsal smooth area brownish (due to viscera); gills pale flesh-color, with flake-white at their bases; tentacles pale, their lamellæ brownish yellow. (Description from living specimen).

Eastport, Me., at low water, Aug. 19, 1872. Collected by the writer while with the U. S. Fish Commission. Drawings were made by Mr. Emerton, and the writer.

Allied to *Doris* (*Acanthodoris*) *subquadrata* Alder and Hancock.

Acanthodoris stellata nob., (=*Doris stellata* Gmelin.)

Doris (*Acanthodoris*) *pilosa* Alder and Hancock, Plate 15, figs. 1–10 (*non Doris pilosa* Müller).

Doris bifida Verrill, this Journal, vol. 1, p. 406. (Variety).

Typical specimens of this species have been repeatedly collected and carefully examined by me, from various parts of the New England coast (New Haven to Eastport, Me.), and agree perfectly with the figures and descriptions by Alder and Hancock, except that the white stellate markings on the gills are usually absent. My *Doris bifida* is only a color-variety.

Acanthodoris citrina sp. nov.

At Eastport, Me., I have observed a more distinct form, probably a new species. In this the body is more depressed and elongated, elliptical; the frontal veil is crescent-shaped, with the angles much produced, and with two, more prominent, tentacular papillæ in front. Mantle covered with small, soft, conical, acute, yellow papillæ, with yellow granules between them. Branchiæ nine, broad, bipinnate and tripinnate, in expansion nearly reaching the sides of body, the two posterior

small, all united beneath by a short web. Color, pale lemon-yellow, specked with bright yellow; gills yellow; tentacles and edge of mantle orange. Length 25mm; breadth 8 to 10mm.

Adalaria proxima Bergh, (=*Doris proxima* Alder and Han.)

Specimens of this species were collected at Eastport, Me., by the writer and Professor S. I. Smith, in 1864, and also in subsequent years. They agree perfectly, both in external characters and dentition, with the English specimens.

Onchidoris muricata (Müller). H. and A. Adams.

Specimens, apparently identical with this species, were obtained at Eastport, Me., with the preceding.

Onchidoris diaphana (Alder and Han.)

Not uncommon at Eastport, Me., where I obtained it in 1864, '68, '70, at low-water, under stones.

Coryphella rutila, sp. nov.

A large, brilliantly colored species, remarkable for the small size of the head. Foot broad, pointed, but not much elongated posteriorly; auricles very long, often equal to breadth of foot, slender, acute, with a fold or groove in front. Head small, rounded, often emarginate in front, with the mouth large and subterminal. Oral tentacles arising from sides of head, slender, elongated, tapering, slightly wrinkled; dorsal tentacles slightly stouter and longer, wrinkled, arising near together; eyes not observed. Branchiæ numerous, long, rather slender, slightly fusiform, arranged in eight to ten, usually well-separated, transverse clusters, mostly of two rows each, usually six to eight in each row; anteriorly the clusters become more crowded. Color, yellowish white, translucent; branchiæ with a bright vermilion nucleus, the tips, for some distance, flake-white; dorsal tentacles pale yellowish, usually tipped with white. Length, 48mm; breadth, 7mm; dorsal tentacles, 10mm; oral, 9mm; branchiæ, 9·5mm.

Eastport, Me., 1864, 1868, 1872, found at low-water, sometimes under stones, but often entirely exposed, creeping over algæ. It is allied to *Æolis pellucida* Alder and Hancock.

Cuthona Stimpsoni, sp. nov.

A species of *Cuthona*, allied to *C. Peachii* Ald. and Han., is not uncommon at Eastport, Me., where I have observed it in 1865, '68, '70 and '72. The tentacles of both pairs appear to be longer than in the English species, and the head to be more produced laterally. The foot is broad, not very acute nor slender posteriorly; auricles small, short, triangular, often directed backward. The head is large, broad, rounded in front, with dis-

tinct rounded lateral lobes. Tentacles slender, slightly wrinkled; branchiæ numerous, crowded, fusiform. Color, yellowish white, with a flake-white line on the upper side of foot, posteriorly; tentacles tinged with salmon, with flake-white specks or a streak, distally; branchiæ with salmon, yellowish brown, reddish brown, or purplish nucleus, and specked at the end with flake-white, which sometimes forms a ring, near the tip. Length, 10 to 32^{mm}.

ART. XL.—*On the Presence of Chlorine in Scapolites;* by FRANK D. ADAMS. *Contributions from the Laboratory of the Sheffield Scientific School.* No. LIV.

IN the present paper I wish to call the attention of mineralogists to a fact which appears to have been hitherto almost entirely overlooked, namely, the presence of chlorine in minerals of the scapolite family. In a paper which appeared in the Annalen der Chemie und Pharmacie, xlvi, p. 340, 1843, Dr. Carl Schafhäutl details the results of his examination of "Porzellanspath." It was called passauite by Naumann, and classed in Dana's Mineralogy as an altered ekebergite. The mineral was first analyzed and made a distinct species by Fuchs, who, in his Mineralogy, published in 1842, assigns to it the formula

$$4\dot{A}l\,\ddot{S}i + 4\dot{C}a\,\ddot{S}i + \dot{C}l\,Na,$$

which requires 7·83 per cent of sodium chloride. He, however, supports the formula by no analyses. Dr. Schafhäutl employed several methods in determining the chlorine. In one, the powdered mineral was heated in a retort with concentrated sulphuric acid and the distillate caught in a tube containing silver nitrate. This method required care, but gave good results. He then tried fusion with barium carbonate, or sodium carbonate. Only a little chlorine was found when a red heat was employed, and none at all when a white heat was given. But a satisfactory result was obtained by fusing with barium carbonate in a very thin platinum crucible, some of the carbonate being placed on top of the mixture, and the heat supplied by a Fuchs spirit lamp. The quantity of chlorine in the mineral was found to be ·924 per cent, an amount just sufficient to saturate the potassium present. From his analysis he deduced the following formula:

$$4(Al_2O_3, SiO_3) + \left\{ \begin{matrix} 2(CaO, SiO_3) \\ NaO, SiO_3 \end{matrix} \right\} + \tfrac{1}{2}KCl_2$$

This analysis of Dr. Schafhäutl's is the only one in the lists of analyses of scapolites given in Dana's Mineralogy, in which chlorine is mentioned as one of the constituents.

This winter a duplicate analysis of a scapolite from lot 13 of the 8th concession of the township of Ripon, Quebec, was made by the writer, but it fell short of 100 by several per cent. Thinking that a loss must have been incurred at some step in the process, the analysis was repeated, but the results were much the same. The mineral was then tested for fluorine by the method described in Fresenius' Qual. Anal., p. 218, 7, but none was found. It was noticed, however, that by heating the powdered mineral alone in a platinum crucible, a heavy sublimate was obtained which collected in a drop on the cover of the crucible. This sublimate was soluble in water, the solution gave a precipitate with silver nitrate and also one with barium chloride, thus showing the presence of chlorine and sulphuric acid in the mineral. A complete analysis of the mineral was again made in duplicate; this time the chlorine and sulphuric acid were determined, and it was found to sum up satisfactorily. The scapolite occurs in veins varying in width from a few inches to a foot. It is associated with blackish mica, green hornblende, colorless quartz, reddish calcite, green apatite, black tourmaline, and frequently incloses small crystals of brownish sphene. The opening from which the specimens were taken was made in search of apatite, which occurs in the vicinity both in crystals associated with blackish mica and reddish calcite, and also in the finely granular form known to the miners as "sugar phosphate." A portion of one of the apatite crystals was examined and found to contain chlorine. The color of the mineral is white, sometimes greenish-white.

The scapolite occurs in rather large crystals, the exterior portions of which are evidently somewhat decomposed, while the interior is apparently unchanged. It fuses with intumescence at about 3. The lustre of the undecomposed mineral on the basal surface of fracture is sub-vitreous, but elsewhere there is little lustre. The only cleavage observed was paralled to the lateral faces, which are deeply striated. Specific gravity of three specimens was as follows:—2·605, 2·654, 2·626. A portion having the strongest vitreous lustre was selected for analysis. A section made from a fragment of this was submitted to a microscopic examination by Mr. Hawes, who judged that the impurities were not present in sufficient quantity to cause any error in conclusions drawn from the results of analysis.* The chlorine and sulphuric acid were determined by fusing with sodium carbonate, and after digesting the fused mass with water, acidifying with nitric acid and precipitating the chlorine by silver nitrate. The excess of silver in the filtrate was then separated by hydrochloric acid, filtered off,

* Minute quantities of orthoclase and calcite were observed. No disengagement of carbon dioxide could be perceived when the powdered mineral was treated with hydrochloric acid.

and the sulphuric acid precipitated in the filtrate by barium chloride. Since as before mentioned alkaline chlorides are lost by igniting the mineral strongly, the elongated slightly conical crucible designed by Dr. Smith for his alkali determinations, was made use of in estimating the water. The mineral was dried over sulphuric acid in a platinum boat, introduced into this crucible and kept at a bright red heat over a fish-tail Bunsen lamp until it ceased to lose weight. The flame of a Bunsen lamp was occasionally passed across the mouth of the crucible but no yellow coloration was imparted to it, and on rinsing out the crucible with distilled water only a trace of chloride was found in solution. The remaining constituents were determined in the usual way.

The results of the analyses are as follows:

		I.	II.	Mean.
SiO_2		54·859	54·858	54·859
Al_2O_3		22·128	22·769	22·448
Fe_2O_3		·486	·486	·486
CaO		9·164	9·020	9·092
MgO		trace.	trace.	trace.
K_2O		1·241	1·013	1·127
Na_2O		8·358	8·373	8·365
Cl	(2·473)	2·485	2·276	⅔ 2·411
SO_3		·823	·770	·796
H_2O (comb.)		·143	·139	·141
H_2O (hygr.)		·722	·723	·722
		100·409	100·427	100·447
Deduction for O replaced by Cl,		·59	·59	·59
		99·819	99·837	99·857

Assuming chlorine and sulphuric acid to be combined with sodium, the atomic and quantivalent ratios calculated from the mean of the above analyses, are:

	Atomic.	Quantivalent.		
Si	914 × 4	3656		3656
Al	438 × 3	1314	1332	
Fe	006 × 3	18		
Ca	162 × 2	324	324	1886
Na	206	206	230	
K	024	24		
NaCl	068			
Na_2SO_4	010			
H_2O	032			

Excluding NaCl and Na_2SO_4, the quantivalent ratio for basic elements and silicon is 1886 : 3656=1 : 1·94, approximately that required by a bisilicate (1 : 2). It is therefore more acidic than any of the members of the scapolite family with the exception of dipyre and marialite.

As many of the analyses given in Dana's Mineralogy foot up to less than 100, some of them being as low as 97 and 98, it

was thought that the deficiency might be due to chlorine, which had been overlooked in the analyses. Accordingly fourteen specimens of scapolite, from different localities, were selected and examined for this element. It was found in every case, though in some of them the amount present was small. They were tested by heating some of the finely pulverized mineral to whiteness in a platinum crucible, by means of a powerful blast lamp, the flame being slanted so as not to heat the upper portion of the crucible more than necessary. The sublimate obtained on the cover was dissolved in water and the usual tests applied. In the following table the percentage results of the examination of the scapolites are tabulated. A dash indicates that the constituent referred to has not been tested for.

	Chlorine.	Sulphuric Acid.	Loss on ignition at a red heat.	Carbonic Acid.
Gouverneur, N. Y.	Cl. pres.	—	—	None.
Lewis Co., N. Y.	" "	—	—	—
Edenville, Orange Co., N. Y.	" "	—	—	CO_2 pres.
Monroe, Conn.	" "	—	—	—
Bolton, Mass., (Pink scap.)	" "	—	—	CO_2 pres.
" " (Whitish ")	" "	—	—	" "
Pierrepoint, N. Y.	" "	H_2SO_4 pres.	—	—
Meionite, Mt. Somma, Italy.	" "	" "	—	—
Arendal, Norway.	" "	" "	—	CO_2 pres.
Malsjö, Wermland, Sweden.	" "	" "	—	" "
Templeton (21st lot of 12th range) Queb., massive and banded.	" "	" "	—	" "
Ripon (13th lot of 8th range) Quebec. High lustre.	2·411	·796 (SO_3)	·722	None.
Ripon (13th lot of 8th range) Quebec. Less lustre.	1·468	—	1·496	CO_2 pres.
Ripon (13th lot of 8th range) Quebec. Less lustre.	2·011	—	—	" "
Hull (8th lot of 14th range) Quebec.	·2026	H_2SO_4 pres.	—	" "
Trumbull, Conn.	($\frac{3}{7}$) 1·783	—	·337	None.
Kokken, near Krageröe, Norway.	2·013	H_2SO_4 pres.	($\frac{3}{7}$) 1·903	CO_2 pres.
Passauite, Passau (Schafhäutl.)	·924	—	1·2 (water)	—

Dr. B. J. Harrington informs me that he has found chlorine in other scapolites from the township of Templeton, Quebec, both in crystallized and massive specimens, though he has not determined the amount present. When the mineral contains only a small quantity of chlorine, as in the cases of the specimens from Arendal, Malsjö and Templeton, it cannot be detected with certainty by igniting the mineral, but it is easily found by Rose's method, which will be mentioned farther on. In order to ascertain what quantity of chlorine must be present in the mineral to be detected by the ignition test, the scapolite from

Hull, which gives off only a trace on ignition, was examined by Rose's method and found to contain ·202 per cent of chlorine. It is therefore probable that those specimens, whose sublimate gave a distinct precipitate with silver nitrate contained above that amount. In every case in which the sublimate was tested with barium chloride, a white precipitate was obtained. In the scapolite from Ripon this was due to sulphuric acid contained in the mineral, but in other cases it may possibly have been due to fluorine. The blue sodalite occurring at Litchfield, Me., loses alkaline chlorides when ignited, in the same manner as the scapolites. The sublimate contains a trace of sulphuric acid in addition to the chlorine. A specimen of wilsonite, from Bathurst, Ont., when subjected to the same test, gave no sublimate, but another specimen of the same mineral from the fifth lot of the tenth range of Hull, Quebec, gave a slight sublimate which contained a trace of sulphuric acid, but no chlorine. The meionite mentioned in the table gave a comparatively heavy sublimate.

Dr. Schafhäutl, in his paper referred to above, states that his "Porzellanspath" lost all its chlorine when fused with sodium carbonate at a white heat, and that only a trace remained if a red heat was employed. In order to ascertain whether my analysis was deficient on this account, I determined the chlorine in a white scapolite from Trumbull, Conn., both by fusing it with sodium carbonate, over a powerful circular Bunsen lamp, and also by Rose's method. This method consists in decomposing the mineral in the cold by hydrofluoric acid in the presence of weak nitric acid. The calcium fluoride is filtered off, and the chlorine determined in the filtrate by precipitating with silver nitrate. The results were as follows:—

By decomposition with hydrofluoric acid.....	1·824 per cent.
By fusion with sodium carbonate.....	1·756 "
Difference.....	·068

The loss is therefore very small. The scapolite from Ripon is not easily decomposed by sulphuric acid. In an experiment conducted by Mr. Comstock in this laboratory, two grams of the finely pulverized mineral were treated with concentrated sulphuric acid for three hours and a half at a temperature between 160° and 200° C., but only a trace of chlorine was given off. Dr. Schafhäutl also states that at a red heat every trace of chlorine was expelled from his mineral, and that some of the chlorides were dissolved out by water. That such is not the case with all scapolites is seen from the following experiments conducted on the same material from Ripon: ·87 of a gram was heated to intense whiteness in a platinum crucible and fused down to a transparent, colorless, vesicular mass. It lost 5·178

per cent, but the residue gave a heavy precipitate with silver nitrate when examined by Rose's method. It was found that only a very small quantity of the chlorides escaped at a high red heat, a white heat being required to expel them in large quantity, although even at that temperature some remain as proved by the last experiment. About half a gram of the finely powdered mineral was treated with cold distilled water for about forty-five hours, but not a trace of the chlorides went into solution. The scapolites mentioned in the table, which contain the highest percentage of chlorine, are generally sound and undecomposed. Two specimens of the Ripon mineral, with little or no luster, were found to contain less chlorine than an undecomposed specimen with a high lustre. Fuchs states that the "Porzellanspath," examined by him, lost a portion of its chlorides on decomposition. The specimen from Hull, which contained only ·202 per cent, was almost entirely devoid of lustre and contained carbon dioxide. It is therefore highly probable that chlorine is lost, and not gained by the decomposition of the scapolite minerals.

It is possible that in some cases at least the failure of scapolites to give a good formula, may be due to the fact that sufficient alkali to combine with the undetermined chlorine present has not been deducted before attempting to deduce the formula.

My best thanks are due to Professor Allen, who has kindly directed this investigation.

SCIENTIFIC INTELLIGENCE.

I. Physics.

1. ***On the Formation of Mountains and the Secular Cooling of the Earth;*** by G. H. Darwin.—The letters of Mr. Wallace and Mr. Fisher in Nature, vol. xix, pp. 121, 172, 244, 267, raise the question as to whether or not it is possible that the interior of the earth can be cooling more rapidly than the exterior. The following is an attempt to answer the query as to where the loss of temperature per unit of time is greatest.

Sir W. Thomson (see Thomson and Tait, "Nat. Phil.," App. D) considers the cooling of "a solid extending to infinity in all directions, on the supposition that at an initial epoch the temperature has had two different constant values on the two sides of a certain infinite plane." The solution given is—

$$v = v_0 + \frac{2V}{\sqrt{\pi}} \int_0^{\frac{x}{2\sqrt{(kt)}}} e^{-z^2} dz$$

where k denotes the conductivity of the solid, measured in terms of the thermal capacity of the unit of bulk; V, half the difference

of the two initial temperatures: v_0, their arithmetical mean: t, the time; x, the distance of any point from the middle plane; v, the temperature of the point x at time t.

The above solution shows that for all values of the time when $x=0$, $v=v_0$, so that the temperature at the medial plane is constant.

Then differentiating v with regard to the time we have—

$$-\frac{dv}{dt}=\frac{V}{2\sqrt{(\pi k)}}\ \frac{x}{t^{\frac{3}{2}}}\ e^{\frac{-x^2}{kt}}.$$

This expression is that required for the rate of cooling. We now wish to find where it is a maximum. Consider the function $z\,e^{-z^2}$; this is clearly a maximum when $\log z - z^2$ is a maximum, and by the ordinary rules this is a maximum when $\frac{1}{z}=2z$, or when $z^2=\frac{1}{2}$. Hence it follows that $-\frac{dv}{dt}$ has its maximum value where $x^2=2kt$. Now when the unit of length is a foot and of time a year, $k=400$; hence $x=\sqrt{800t}$.

This formula shows that the seat of the maximum rate of cooling moves inward as the time increases. If the time which has elapsed from the initial state be two hundred million years, or $t=2\times10^8$, we have $x=400{,}000$ feet, or a little less than eighty miles.

Sir W. Thomson shows, in his paper on the Secular Cooling of the Earth, that the solution of his ideal problem will be very nearly correct for the case of the earth, which is supposed to be a hot sphere cooling by radiation. It follows, therefore, from the numerical result which is given above that the seat of the maximum ratio of cooling must probably be something like 100 miles below the earth's surface. It does not, of course, necessarily follow that the seat of the maximum rate of contraction of volume should be identical with that of the maximum rate of cooling; yet it seems probable that it would not be very far removed from it.

The Rev. O. Fisher very justly remarks that the more rapid contraction of the internal than the external strata would cause a wrinkling of the surface, although he does not admit that this can be the sole cause of geological distortion. The fact that the region of maximum rate of cooling is so near to the surface recalls the interesting series of experiments recently made by M. Favre (of which an account appeared in Nature, vol. xix, p. 103), where all the phenomena of geological contortion were reproduced in a layer of clay placed on a stretched india-rubber membrane, which was afterwards allowed to contract. Does it not seem possible that Mr. Fisher may have under-estimated the contractibility of rock in cooling, and that this is the sole cause of geological contortion?—*Nature*, Feb. 6.

2. *On Binaural Audition.**—In a recent number of the Philosophical Magazine (March, 1879), STEINHAUSER discusses the theory of direct Binaural Audition. Some of his conclusions are stated as follows:

(1.) The direction in which a source of sound is situated, may be estimated by the different intensities with which a sound is perceived in the two ears. (2.) The standard of each individual for the perception of the direction of sounds is dependent upon the angle β, that is, the angle included between the effective surfaces of the pinnæ of the ears and the line of sight. (3). The smaller the angle included between the line of sight and the surfaces of the pinnæ, the more certain will be the perception of the direction of sound. (4.) We hear best with the two ears when the sound reaches us from the front in the line of sight. (5.) Persons equally hard of hearing in one ear must, in order to hear as well as possible, turn the better-hearing ear the more towards the speaker in proportion as the angle which the surfaces of their pinnæ make with the line of sight is less. (6.) The power of perception of the direction of a sound is not vitiated by an equal hardness of hearing in both ears. (7.) For most persons the angle β (above defined) is less than 30°, which explains the well-known position assumed by the listener who turns one ear towards the source of sound. (8.) We hear binaurally the best, relatively, when the source of sound is situated in that plane in which are situated the line of sight and the line joining the middle points of the pinnæ ("plane of best hearing") and the best, absolutely, when it is situated in the line of sight. (9.) In the case of hearing a sound coming from above or below, we are able to estimate, from the relative intensities with which the sound is perceived in the two ears, the azimuth of the rays of sound as projected upon the plane of best hearing.

The last principle explains the method which we pursue to discover the position of a source of sound whose situation is unknown, and which consists in a motion of the head.

For example, to find a source of sound situated anywhere *above*, we have only to turn the head about a vertical axis until we hear equally with both ears and with the greatest total intensity. Then the line of sight coincides with the horizontal projection of the direction of the sound. The head must then be turned upwards about a horizontal axis at right angles to the line of sight, as long as the intensity of the sensation increases. When this reaches its maximum, and is equally great for both ears, then the source of sound must be situated in the line of sight. And here we must remark on the essential importance of the actual conditions—that the ears and eyes, being alike attached to the head, share its movements, and that they are situated at almost the same height above the ground.

Should we perceive a falling-off in the intensity of the sound on raising the head, this would be an indication that the source of

* See this Journal, January, 1879, p. 64.

sound is situated *below* the plane of best hearing, and that we should be able by sinking the head to bring the source of sound into the line of sight in the manner just described for a sound above the head.

It is intelligible and natural that, where (as in an instrument for measuring altitude and azimuth) we have two separate motions of rotation at right angles to one another, it is immaterial whether the movements in the two directions be executed separately or by a simultaneous motion of the head. This occurs, for example, when we try to find a lark which we may hear singing above a field. We raise the head, making an arbitrary guess at the position of the lark in the sky. Then we turn the head about, led meanwhile *by ear* until we hear equally well with the two ears and with the greatest possible intensity; and simultaneously we perceive the lark in the line of sight. We do not, therefore, as it might be conjectured in this case, seek for the source of sound by means of the eyes, but *by means of the ears.*

3. *The Faraday Lecture before the Fellows of the London Chemical Society*, November 12, 1878, by Professor AD. WURTZ of Paris, is published at length in the January number of the Journal of this society. The subject chosen was "Constitution of Matter in the Gaseous State," and is significant after the discussions of the fundamental principles of modern chemistry which have taken place in the French Academy, and to which we have before referred in these pages. The lecture was an elementary exposition of the dynamical theory of the constitution of matter, and of the conception of molecules and atoms which this theory involves, and which Professor Wurtz fully accepts as the theoretical basis of the philosophy of chemistry. The lecture was illustrated, and its chief interest centers in one of the experiments, which, as it would seem, gave a very different result from that obtained by M. Troost from a series of similar experiments, noticed on page 321 of vol. xvi, III, of this Journal. Into the space above the mercury of one barometer-tube chloral-hydrate was evaporated, while the similar space of a second tube was filled with the vapor of chloroform. Into both of these atmospheres crystallized potassic oxalate was then introduced. Very soon a depression of the mercury column indicated that the water of crystallization of the salt had evaporated into the dry vapor of chloroform, while the constancy of level in the first tube showed that into the vapor of chloral-hydrate no such evaporation had taken place. Hence the conclusion that the space above the mercury in the first tube was already saturated with free aqueous vapor, and therefore that chloral-hydrate must become disassociated when it evaporates. By a reference to loc. cit. the bearing of this experiment will be more plainly seen, and the contradiction presented will serve to enforce the lesson, there suggested, that exceptions to a law so well established as that of the equality of molecular volumes in the aëriform state ought always to be very closely scrutinized.

At the same time with the address of Professor Wurtz we have before us a similar address by Professor Bayer, the successor of Liebig at Munich, and one of the most distinguished representatives of the German School of Organic Chemistry. It was delivered before the Königl. Akademie der Wissenschaften on the occasion of the birthday of King Ludwig of Bavaria, and is reprinted, with no flattering comments, by Professor Kolbe in the December number of the Journal für prakt. Chemie. The nominal subject of the address was "Chemical Synthesis," and we should have expected that, before such an audience, the eminent chemist, who had so recently made the synthesis of indigo blue, would have dwelt on the philosophy of the method by which this great result had been obtained; and, certainly, the circumstances connected with the synthesis both of indigotine and of alizarine illustrate most strikingly the great value of even the conventional forms of a well grounded "working hypothesis" in guiding scientific investigation. But, so far from this, the address was, for the most part, another popular exposition of the same subject treated by Professor Wurtz, and it contains such grotesque fancies that we can scarcely credit that the words we read were actually addressed to a learned society, even if in open session. We read of systems of atoms branching like trees—as if they were objects of natural history; of the possibility that the molecules of the diamond are large enough to be seen with a microscope, and to be isolated by mechanical pulverizing; of the molecules of marsh-gas as attaining sufficient velocity to carry them beyond the sphere of the earth's attraction, and that the exhalations of our marshes may thus contribute to form those cometary masses in which the spectroscope has discovered the presence of carbon. It would seem as if the purpose of the address were to bring the molecular theory into disrepute by a "reductio ad absurdum;" and while we cannot but regret the rude manner in which Professor Bayer has been ridiculed in the reprint to which we have referred, the address certainly invites criticism, and shows how absurd a good "working hypothesis" may be made to appear if we insist on realizing its conventional and temporary forms. No partial truths will bear such treatment, and these two addresses seem to us worthy of notice in this place as pointing out very clearly the only legitimate use of theory which forms the basis of our modern chemical philosophy. J. P. C.

4. *Experimental determination of the velocity of Light;* by A. A. Michelson, U. S. N., Instructor in Physics and Chemistry in the United States Naval Academy.—In a former number of this Journal (May, 1878, p. 394) a brief description is given by Mr. Michelson of a new method for the experimental determination of the velocity of light. It is based upon the method of Foucault so modified, as there described, as to admit of the use of any distance between the mirrors, and a correspondingly increased displacement of the reflected image. This method has since been put to use by the describer. In his experiments the speed of the mirror was 130

turns per second, the radius of measurement from fifteen to thirty feet, and the distance between the mirrors 500 feet. The displacement varied from 0·3 inch to 0·63, or about twenty times that of Foucault. The mean of ten determinations for the velocity of light in air was 186,508 feet, the extremes being 184,500 and 188,820. The author expresses the hope of being able, under more favorable conditions, to obtain the true result within a few miles.—(*Amer. Assoc. Adv. Science, St. Louis meeting*, 1878.)

II. Geology and Mineralogy.

1. *Note on Mountain-making by the Contraction of the Earth's crust;* by J. D. Dana.—A method of reproducing on a small scale the folding and fracturing of strata has been contrived by Professor A. Favre, of Geneva (Nature, of Dec. 5, from La Nature). He employs a stretched sheet of caoutchouc, to which clay in thin layers has been made to adhere, and allows it gradually to contract to its natural condition. The figures of the results, which he has published, represent foldings, faultings and crushings that look much like some of the effects in the world of rocks.

Mr. H. F. Walling, of Cambridge, in a paper on the relation of adhesion to horizontal pressure in mountain dynamics, read before the American Association at St. Louis in August, 1878, and published recently, suggested, still earlier, essentially the same mode of experimenting.

There are two general facts with regard to *actual* mountain-making that are not in accordance with the results which the caoutchouc affords.

(1.) Contraction in the earth's crust from cooling must have gone on continuously through time, with local differences, especially between the continental and oceanic areas, but still continuously; and therefore the effects, if like those on the caoutchouc, should have occurred all along the ages over the globe. But the fact is, that mountain-making has occurred over the continents only after a very long, quiet interval in which there were no disturbances beyond those from gentle oscillations. Geology has found that, for North America, from the Atlantic south of New York to the Rocky Mountains, and as the facts now stand, to the Pacific, there was but one mountain-making epoch between the close of Archæan time and the beginning of the Triassic era; and that this occurred at or near the termination of Paleozoic time. Thus, for the larger part of the broad continent, at least *three-fourths* of all geological time after the Archæan—amounting to seventy-five millions of years, if the whole covered one hundred millions—passed without any mountain-making disturbance, the greatest of which there is evidence, being that which raised the Lower Silurian about Cincinnati and to the northeast and southwest. During all that long time the sedimentary deposits were slowly thickening over the underlying crust, and lay like the clay over

the caoutchouc, but this supercrust was nowhere bent up into steep folds or bold wrinkles through the contraction in progress.

There was probably disturbance and mountain-making in the Green Mountain region after the close of the Lower Silurian; and it is possible that effects of the same disturbance will be found along the eastern part of the Appalachian region farther south. But, if so, the general truth remains the same; for the close of the Lower Silurian occurred about half way between the Archæan and the close of the Carboniferous, making the antecedent period of quiet, on the above estimate of time, nearly forty millions of years. Over the Rocky Mountain region it is not yet proved that any great disturbances occurred at either of these eras, the first in the Wahsatch and Uintah region taking place not before the close of the Cretaceous.

(2.) The folds often have all the steeper inclinations facing in one direction and the less steep in the opposite, showing that the results of the pressure were unlike in the two opposite directions. The well known facts in the Appalachians, as first announced by Professor Rogers, abundantly illustrate this, and, also, those in the Jura Mountains.

The results obtained with the contracting caoutchouc correspond in one respect with rock-flexures, and it is a point not always considered by those who speculate on mountain-making. In mountain regions the flexures in the earth's strata are not, with very rare exceptions, represented by like flexures in the contracting crust. The former are generally between one and twenty miles in span; and the earth's crust could not have been thin enough at the close of the Paleozoic, when the Appalachians were formed, to have made such narrow bendings.

2. *Notes on the Coral Reefs of the Island of Itaparica, Bahia, and of Parahyba do Norte;* by RICHARD RATHBUN.—In the American Naturalist for July, 1876, I gave a short description of the coral reef skirting the outer shore of the island of Itaparica, in the bay of Bahia, Brazil. From a further examination of the reef and a study of the specimens procured from it, I am able to add a few items of interest to those previously given. I also wish to call attention to the existence of another reef, similar to that of Itaparica, to the south of the entrance to the Rio Parahyba do Norte. It was explored by Mr. John Branner of the Geological Commission. In shape and structure, as well as in the paucity of coral life upon it, this last agrees very closely with the Itaparica reef. It follows the trend of the shore, at a short distance from it, and between the reef and the shore there is an average depth of water of about six or seven feet only. The upper and outer portions of the reef are very irregular, but the inner part is comparatively smooth. No large corals are living upon it; at the northern end were collected a few small specimens of Porites, and toward the south a few Millepores, Symphyllia (?), and Porites. Much of the bottom surrounding the reef is very rich in coral growth. No sections were obtained giving us a clue to its

structure, which is, however, probably the same as that of the Itaparica reef.

In my former description of the Itaparica reef I stated that, while the lower portion was plainly made up in large part of true corals, the upper part appeared to contain only nullipores. I have since found that the worm tubes covering the surface of the reef enter very largely into its structure, probably to as great an extent as the nullipores, and give rise to an exceedingly hard, calcareous rock from which, ultimately, all traces of the worm-tube structure disappear. The worm-tubes and nullipores evidently compose the entire upper half of the reef. The nullipores, in the upper portions, so far as my observations went, were all of the encrusting lichen kind, and resulted in a compact structure, showing a sort of wavy lamination which is due to the successive growths of nullipores. The large digitate nullipores, so common at Pernambuco and at many places in the Bay of Bahia, are limited to the lower part of the reef, where they are associated with the true corals. At present nullipores are living in abundance only on the outer side of the reef, to a height of about one foot above medium low tide. Above the line of nullipores we find the entire upper surface of the reef coated with a layer of living worm tubes and large barnacles. The latter are generally broken off by the waves when dead, but the former remain, producing a loose structure near the surface, which becomes more compact below. The existence of nullipores in this upper portion indicates, however, that they lived on top of the reef at no distant time, and probably also that the reef has been elevated to a slight extent since then.

Within the reef the water is very shallow, being deepest near the reef and especially at and around the openings through it; it gradually shallows inward toward the beach. The bottom of this shallow inner channel is covered with sand and fragments of all sizes of corals and shells. Corals were not found in an upright position in this channel, nor do living corals exist there at all. The coral fragments are all old, frequently much worn, and almost invariably covered with nullipore and bryozoan growths, also dead. They form beds of considerable thickness in places, often more or less consolidated, and are dug up to burn for lime. The species discovered among the fragments are all found living in various parts of the bay, excepting *Mussa Harttii*, which does not apparently live at present anywhere in the Bay of Bahia. This extensive accumulation of broken corals, which must have been formed by the breaking off and heaping up of living corals from the surface of the reef by the breakers, when the reef was at a lower level, testifies to the exceeding richness of the coral life at that time. Corals have apparently ceased to be reef-builders in the Bay of Bahia.

3. *Semi-metamorphic fossiliferous rocks containing Serpentine.* —Dr. J. W. Dawson mentions facts on this subject from which the following are cited.

On the Saguenay River, at Lake Chebogamong, there is a band of serpentine associated with limestone; and Mr. Richardson obtained there a fossil tabulate coral which has part of its cells filled with serpentine, and also veins of serpentine intersecting it. The species is *Astrocerium pyriforme*, a species very common in the Upper Silurian limestones of the region in which it occurs, and characteristic especially of the Niagara formation. The formation containing the serpentine and limestone "is described as consisting of chloritic slates, in some places with hornblende crystals, dolomites, and hard jaspery argillaceous rocks."

At Melbourne, in the province of Quebec, rocks, referred by Logan to the Quebec group, pass upward into a thick series of hydromica schists, associated with quartzose bands and lenticular layers of crinoidal limestone. Over these, according to Logan, lies serpentine in thick beds (undoubtedly bedded rocks and not "eruptive") with other hydromica schists, limestone breccia, arenaceous beds, beds of anorthite, steatite, dolomite and red slates. The serpentine in the line of strike passes into dolomite and red slate. Fossils occur in the limestone interstratified with the serpentine, and also disseminated serpentine. The fossils are "*crinoidal* joints, fragments apparently of *Stenopora*," and tubular bodies which may be portions of *Hyolithes* or *Theca*, having an interior of calcite and a coating of serpentine. The cells of the fossils are sometimes filled with the serpentine; and the crinoidal joints are surrounded by it, with dolomite within.

Slices of these specimens, and those of other localities, were made by Mr. Weston when under the direction of the late Sir W. E. Logan. The other localities include Stamford, Farnham, Cleveland, Bedford, Oxford, Athabaska, Point Levi, Rivière du Loup, in most of which Lower Silurian fossils occur associated with hydrous silicates.

A locality at Pole Hill, in New Brunswick, discovered by Mr. C. Robb, has afforded specimens consisting of "fragments of crinoids and shells finely injected with an olive-green hydrous silicate of alumina, iron and magnesia. In one shell, apparently an *Orthoceras* or *Theca*, the dark green filling has cracked in the manner of Septaria [as often true of crinoidal stems in the Subcarboniferous of the Mississippi valley] and the fissures have been filled with carbonate of lime.

4. *The Physical History of the Triassic Formation of New Jersey and the Connecticut Valley*; by I. C. Russell (Ann. N. Y. Acad. Sci., i, 220–254).—The author, after giving some account of the Triassic formation of New Jersey and the Connecticut Valley, discusses the origin of the westward dip of the former and eastward of the latter. He adopts the hypothesis, suggested by Professor Kerr for the Trias of North Carolina, and by Professor F. H. Bradley for the regions of which Mr. Russell treats, that the New Jersey and Connecticut beds are opposite parts of an anticlinal. He holds also that the sandstone was once continuous over the whole intermediate region. The view is sustained on the ground

that the dip of the sandstone is in opposite directions in the two areas—10° to 15° northwestward in New Jersey, 5° to 50° [averaging 15°] to the eastward and southeastward in the Connecticut Valley; and on the view of a conglomerate on the western border of the former and eastern of the latter, whence it is inferred that here were the coast lines of the great estuary. Calculations from the dip give him for the thickness of the sandstone 25,000 feet, the consideration of faults in the beds being rejected by the author as without "plausible" support.

The hypothesis has objections, some of which, as they appear to the writer, are here stated.

(1) A thickness of 25,000 feet of water-made sandstone over an area of metamorphic rocks more than 100 miles in width, large portions of which are now several hundred feet above the sea-level, implies a subsidence of this region of over 25,000 feet, during the formation of the sandstone, or else, this depth of water.

(2) It implies also an elevation of the whole region—100 miles wide between the eastern and western limits—not only to this amount, 25,000 feet, but enough higher to give the average pitch of 15° eastward in the eastern sandstone and 10° to 15° in the western. For a width in the Connecticut Valley of fifteen miles (the area averages twenty), the dip produced by the alleged uplifting if only 14°—supposing no faults—would put the *western side of the Connecticut Valley* 20,000 *feet above its eastern;* and the site of New York City, on the eastern 15,000 or 20,000 feet above its present level, with 25,000 feet of sandstone over it. How much higher such an elevation would place the central portion of the region between the Connecticut Valley and New Jersey, the reader can calculate. Mountains on the globe at the present day are small in comparison.

(3) The hypothesis asks for an incredible amount of denudation; crystalline rocks of great depth as well as sandstone, over an area more than fifty miles wide having to be removed, and the surface brought down to its present level.

(4) The southern limit of the Connecticut Valley sandstone area is *north of the northern* limit of the New Jersey. The New Jersey area cannot, therefore, be on the opposite margin of the sandstone region to that of the Connecticut Valley. That there should have been an opposite side to the Connecticut Valley anticlinal, the New Jersey Trias should have extended up the Hudson River to Albany, N. Y., 120 miles north of its most northern point, Albany being in the same latitude with its northern limit in the Connecticut Valley; and hence the whole of western Massachusetts as well as of Connecticut, and all of Eastern New York, south of Albany, including the Green Mountain region, must have been raised to the enormous altitude referred to; and, besides, the sandstone must have since been removed from the whole so that no trace was left, with the exception of the Southbury basin. Further, the opposite side of the New Jersey part of the arch must have been somewhere out in the Atlantic south of

Long Island; and this island must have participated in the upward bend.

It is however to be admitted that, with the suggested method of accounting for the dip in the Connecticut Valley sandstone, there was no need of any sandstone in the Hudson River Valley; and, no need, in fact, of any sandstone over the intermediate region of crystalline rocks between that valley and the New Jersey area.

(5) No evidence of such an anticlinal, or of the supposed amount of erosion, exists excepting this—that the sandstone of the Connecticut Valley dips eastward, and that of New Jersey, situated wholly to the south of the southern limit of the Connecticut Valley area, dips northwestward, at the angles stated.

The existence of a conglomerate along the eastern border of the Connecticut area can be accounted for on the usual view—that this area in Triassico-Jurassic times was a Connecticut Valley estuary, at the termination of the Connecticut River, and had its violent floods, which may have been for part of the time enlarged by the waters and ice of a semi-glacial era—quite as well as by that of its being the eastern part of a much larger estuary; and even better.

The features of the Connecticut Valley beds afford other arguments; but it is not necessary to bring them up at this time.'

J. D. D.

5. *Geological Survey of Pennsylvania.*—The following volumes containing Reports of Progress of this survey, have been recently issued, in addition to that by Mr. C. A. ASHBURNER mentioned on a former page of this volume. They show great activity in the Survey.

I. *Report of Progress of Bradford and Tioga Counties* (G), 272 pp. 8vo, with maps and sections; including: 1. on the Limits of the Catskill and Chemung formations, by A. SHERWOOD; 2. Descriptions of Coal fields, by F. PLATT; and 3, on the Coking of Bituminous Coal, by J. FULTON.

II. *Report of Progress in Indiana County* (HHH), by W. G. PLATT, 316 pp. 8vo, with a colored map of the County. 1878.

III. *Catalogue of the Geological Museum*, Part I, Rock specimens. 218 pp. 8vo. 1878.

IV. *The Brown Hematite Deposits of the Siluro-Cambrian limestones of Lehigh County, lying between Shimersville, Millerstown, Schnecksville, Ballietsville, and the Lehigh River* (DD), by FREDERICK PRIME, Jr.; 100 pp. 8vo, with 5 map-sheets and 5 plates. 1878.—Professor Prime, shows that the rocks of the region, above the Laurentian, are, in succession, (1) the Potsdam sandstone; (2) a Siluro-Cambrian magnesian limestone, which has afforded Chazy fossils, besides an Orthoceras and Lingulæ too imperfect for determination; (3) Damourite (Hydromica) slates, all in general conformable; also (4) the Trenton limestone, as a direct continuation of the magnesian limestone, the beds affording encrinital stems identical with those found in Northampton

County overlying characteristic Trenton fossils; and (5) Hudson River slates, also conformably continuous with the preceding. Professor Prime treats also of the origin of limonite beds associated with the damourite slates, and of other points in the geology of the region. His method of determining the age of the crystalline schists by means of the fossils in the conformably associated strata gives positive results.

V. *Special Report on the Trap-Dykes and Azoic Rocks of Southeastern Pennsylvania* (E), by T. Sterry Hunt. Part I. Historical Introduction. 254 pp. 8vo. 1878.—This Historical Introduction is a general exposition and re-statement of the author's views on the "Azoic," Cambrian and Silurian rocks, of this and other countries, and the application of lithology to classifying and fixing the age of the various crystalline rocks, besides notes on eruptive rocks, along with a historical account of former views on these and other subjects, and a statement of the observations from various sources that appear to favor the views set forth. It is valuable as a definite exhibition of the present state of such views in the science, and of the arguments—not always just to the observations of others—by which they are sustained. The progress of the science will show how much of truth there is in them.

J. D. D.

6. *Report of the Geological Survey of Ohio.* Vol. III, *Geology and Palæontology.* Part I, *Geology.* 954 pp. 8vo.—This large volume consists, after its Preface by Professor J. S. Newberry, the head of the Survey, of a Review of the Geological Structure of Ohio by Professor Newberry, and chapters on the Geology of different counties by the same, and the Assistant Geologists, Messrs. J. J. Stevenson, M. C. Read, A. W. Wheat, Edward Orton, John Hussey, F. C. Hill, A. C. Lindemuth, J. T. Hodge and H. Herzer, with supplemental Reports by E. B. Andrews and E. Orton.

From Professor Newberry's Review we take the following conclusions.

The Cincinnati group does *not* represent the Hudson River group of New York, but the whole Trenton series, including the Trenton limestone and Hudson River group.

Many fossils of the Oriskany sandstone in Canada West, as *Spirifera arenosa*, *S. arrecta*, *Rensellaeria ovoides*, and *Avicula arenosa* are found mingled with *Favosites Gothlandica*, *Zaphrentis prolifica*, *Conocardium trigonale*, *Platyceras nodosum*, and many other well known fossils of the Corniferous limestone, which facts, in addition to the entire absence of Upper Silurian species, prove the Oriskany to be much more closely allied to the Devonian than to the Silurian.

The "Black shale" or "Huron shale" of the Devonian is made up of the black shales of the Lower Portage and the Genesee. In the shale, besides the gigantic *Dinichthys*, the jaw of a large Placoderm has been obtained which has been referred to a new genus, *Diplognathus*, also a new species of *Dinichthys*, a new *Ctenacanthus*, and several of *Cladodus*.

The volume contains much of great value to the science that would be here cited but for the limited space.

7. *Journal of a Tour in Marocco and the Great Atlas;* by Sir JOSEPH DALTON HOOKER, President R.S., etc., and JOHN BALL, F.R.S.;—*with an Appendix including a sketch of the Geology of Marocco;* by GEORGE MAW, F.G.S., etc. 499 pp. 8vo. London: 1878. (Macmillan & Co.).—This volume contains an account of a journey made by Sir Joseph Hooker, Mr. Ball and Mr. Maw in 1871 to a region which, as the preface remarks, was then little better known to geographers than it was in the time of Strabo and Pliny. The general account of the journey, occupying the first 348 pages, contains, besides incidents by the way, much information on the features, vegetation, and people of the country. It is followed by Appendixes on the Geography of the region, by John Ball; on its economic plants, a comparison between the Flora of the Canary Islands and of Marocco, and between that of Tropical Africa and of Marocco, by J. D. Hooker; on the Mountain Flora of two valleys of the Great Atlas, by J. Ball; on the Geology of the plain of Marocco and the Great Atlas, by George Maw.

The geological chapter contains much on the glacier phenomena of the Atlas region. "Unquestionable moraines" were observed in the province of Reraya, at a height of 6,000 feet, where was a "gigantic ridge of porphyry blocks," "with no admixture of small fragments," 800 to 900 feet in vertical height, damming up the deep ravine. The beds of bowlders flanking the northern escarpment of the Atlas plateau spread downward in great mounds and undulating ridges from a height of 3,900 feet to the borders of the plain 1,900 feet above the sea; and the moraines, commencing at a height of 5,800 feet, stretch up the Atlas ridge to a height of between 7,000 and 8,000 feet. Behind the moraines, at 6,200 feet, there was observed a plain of shingle, which seemed to be the bed of a small lake. At present there is not even perpetual snow on any part of the Atlas range. Since the era of the glaciers, the coast line has been raised at least seventy feet, as indicated by raised beaches at Mogador "which may possibly be cotemporaneous with raised beaches on the coasts of Spain and Portugal." A slight subsidence of the coast-line is stated to be now going on.

8. *Annual Report of the State Geologist of New Jersey, for* 1878. 132 pp. 8vo.—The prominent feature of this Report is a chapter on the "Glacial and Modified Drift" of the State, which is illustrated by a large map, showing the surface covered by the drift, the course of the "terminal moraine," and the "Oak Lands" and "Pine Lands." It treats also of the soils of the State, clays and their compositions, clay deposits, glass sand, progress of the topographical survey of the State, and gives analyses of some iron ores and limestones.

9. *Geological Record for* 1876; *an account of works on Geology, Mineralogy, and Palæontology, published during the year; with supplements for* 1874 *and* 1875. Edited by WM. WHITAKER, B.A., F.G.S., of the Geological Survey of England.

415 pp. 8vo. London, 1878. (Taylor & Francis.)—The third volume of the Geological Record is fully up to its predecessors in scope and thoroughness. The value of the work, to all engaged in the sciences included, would seem to be so obvious that it is a matter of surprise and regret that the editor should be compelled to call for more subscribers to insure its continued success.

10. *The Study of Rocks; An Elementary text-book of Petrology;* by FRANK RUTLEY, F.G.S., of the Geological Survey. 319 pp. 12mo. London: 1879. (Longmans, Green & Co.).—The study of rocks by the microscope is now recognized as so important a part of lithology and so universally employed, that an English text-book giving the methods employed cannot fail to be appreciated. The work is about equally divided between the description of methods of making thin sections and of examining them in the microscope, the description of the rock-making minerals, and of the rocks themselves. Mr. Rutley's work is a convenient one for the student. It is not, however, free from errors; the description and figure on page 94 show that the mineral referred to must be *microcline* and not orthoclase.

11. *Ueber die Zusammensetzung der Lithionglimmer*, von C. F. RAMMELSBERG.—Professor Rammelsberg has made a new examination of the lithia mica, lepidolite, with special reference to the amount of alkalies present. He finds that many of the previous analyses are incorrect in the determination of the lithia, and in this respect he rejects the analyses of Berwerth upon which Tschermak based his recent conclusions as to the chemical formula (this Journal, III, xvii, 176). For the lepidolite of Paris, Me., and Rozena, Rammelsberg writes the formula $\dot{R}_2\dot{R}\dot{R}Si_3O_{10}$.—(*Ber. Ak. Berlin*, Oct. 28, 1878.) E. S. D.

12. *On the composition of Spodumene and Petalite;* by C. DOELTER.—Dr. Doelter has recently analyzed spodumene from Norwich, Mass., (1) and from Brazil (2) with the following results:—

	SiO_2	AlO_3	FeO	CaO	MgO	Li_2O	Na_2O	K_2O	
(1)	63·79	27·03	0·39	0·73	0·21	7·04	1·10	0·12	=100·41
(2)	63.34	27·66	1·15	0·69	...	7·09	0·98	..	=100·91

After making allowance for impurities, he obtains for the quantivalent ratio of $\dot{R}:\dot{R}\dot{R}:Si = 1:3:8$ (instead of 1:4:10 previously accepted) and writes the formula $\dot{R}_2\dot{R}\dot{R}Si_4O_{12}$, where $\dot{R}=Li$ and Na in the ratio of 15:1.

The composition of petalite is also discussed and the conclusion reached that is expressed by the formula $\dot{R}_2\dot{R}\dot{R}Si_{10}O_{24}$, and the opinion is advanced that petalite bears the same relation in composition to spodumene that albite does to anorthite. E. S. D.

13. *Cacoxenite from Lake Superior.* (Communicated).—Mr. E. CLAASSEN of Cleveland has identified cacoxenite on the martite of Lake Superior. It appears in brownish-yellow acicular crystals forming radiating tufts.

14. *A titaniferous Chrysolite.*—M. DAMOUR has described a titaniferous chrysolite from Zermatt, Switzerland. It has a red color, similar to that of almandine garnet; G.=3·27. An analysis afforded SiO_2 36·14, TiO_2 6·10, MgO 48·31, FeO 6·89, MnO 0·19, ign. 2·23=99·86; this gives almost exactly the required ratio of 1 : 1 for bases to silicon.—(*Bull. Soc. Min. France*, ii, 15.)

15. *On the crystalline system of Pyrostilpnite* (*Fireblende*).—STRENG, in a paper devoted to a thorough crystallographic description of some silver minerals from Chañarcillo, Chili, states that pyrostilpnite (feuerblende) belongs to the orthorhombic, not the monoclinic, system. The conclusion is based both upon the measured angles and the optical character.—(*Jahrb. Min.*, 1878, 897).

16. *Die Meteoritensammlung der Universität Göttingen*, von C. KLEIN.—The collection of meteorites at Göttingen, according to the recent catalogue of Professor Klein, is one of the great collections of the world, including meteoric stones from 115 distinct falls, and 90 meteoric irons from different localities.

17. *Enstatite rock from South Africa.*—Professor Maskelyne has described a rock from two localities in the Transvaal, South Africa, consisting solely of massive enstatite. This is a kind previously not recognized in lithology, although rocks have been known which, as lherzolyte, contain enstatite as a prominent ingredient.

III. BOTANY AND ZOOLOGY.

1. *Polyembryony, true and false, and its relation to Parthenogenesis.*—Strasburger has an interesting paper, *Ueber Polyembryonie*, in the Zeitschrift für Naturwissenschaft of Jena (1878), which we know as yet only at second hand, chiefly from a notice in the Archives des Sciences Phys. et Nat. of February, 1879.

Strasburger's researches upon the fecundation of the angiospermous Phænogams show that the embryo-sac very seldom produces more than one embryonal vesicle which is fecundated or capable of being fecundated. The single constant exception to this rule, known to him, is that of *Santalum album* which produces two; and one or two Orchids are mentioned in which the embryonal vesicle divides into two, occasionally. True polyembryony must therefore be very rare in Angiosperms. But seeds containing more than one embryo are of common occurrence in oranges, in *Funkia*, *Allium* or *Nothoscordum*, etc. According to Strasburger, all supernumerary embryos in such cases are adventitious, originate outside of the embryo-sac by a kind of prolification in the nucleus, and are not fecundated at all. They appear in the form of minute cellular protuberances, which lengthen by degrees and push into the embryo-sac by a sort of hernia, or pierce their way into it, becoming in the ripe seed veritable embryos, which it is not easy to distinguish from the one resulting from the fecundation of the embryonal vesicle itself. Independent as these adventive embryos are of fecundation, yet Strasburger could not obtain them in *Nothoscordum* when he had extirpated the stamens before an-

thesis and prevented access of pollen. But it appears that *Cœlobogyne* is just a case of this kind, namely, one in which an adventive embryo is habitually produced, instead of the normal embryo which fails from the want of fecundation, the male plant not being in cultivation. It is understood that this is not a mere inference, but that Strasburger has traced the development of the embryonal vesicle in the ovule of *Cœlobogyne*, followed by its failure and resorption, and by the independent production of adventive embryos in the manner above described.

This, then, gives an explanation of the long-disputed *parthenogenesis* of *Cœlobogyne*, and therefore of the less notable instances.

Parthenogenesis, it is then concluded, is only in appearance; it is sometimes, and perhaps in all cases, "a prolification of the nucleus." Now we should insist that, since the result is "a veritable embryo" (equivalent in structure, position of radicle, and ultimate growth to the true embryo), and not a bud, parthenogenesis is the just name; that the very interesting and important conclusion attained is that parthenogeny results, not from the development of an unfecundated embryonal vesicle, as was supposed, but from a development of other and extraneous cells into an embryo; also that it is not very rare, since the adventive or supernumerary embryos of various seeds are cases of this par thenogeny.

Not the least interesting consideration is, that we have here a counterpart of what De Bary terms *Apogamy*,— instead of an analogue of it. *Apogamy* is a vegetative prolification from what should normally result in the product of sexual reproduction. *Parthenogeny* proves to be the inverse of this, a vegetative production in the ovule of the proper result of sexual reproduction, viz: embryo. And finally, we have in these two modes taken together—what was quite to be expected—a manifest and significant narrowing of the *hiatus* between vegetative and sexual reproduction, which Mr. Darwin may turn to account.

Some applications of this new knowledge may be made. It is quite possible that more embryos than we are aware of may be adventive. Rather more than a year ago we gave an abstract in this Journal* of Mr. Francis Parkman's interesting paper on the hybridization of Lilies. It may be remembered that the greater part of his hybrids exactly reproduced the female parent. The explanation which we suggested to him, and which he refers to in his paper, was, that those plants were not really hybrids at all, but were from embryos originated without male influence. What then seemed to us the least improbable explanation, would now appear to be the one altogether probable. A. G.

2. *Notes on Euphorbiaceæ.* By GEORGE BENTHAM. (Extr. Jour. Linn. Society, No. 100, Dec., 1878, vol. xvii. pp. 185–267).—This thoughtful essay presents the general views attained to by Mr. Bentham on working up the genera of the great order *Euphorbiaceæ* for the ensuing volume of the Genera Plantarum. We need

* The number for February, 1878, p. 151.

not specify any of the results, except to indicate the author's decision in the case of the *Buxeæ*. He does not follow his predecessors, Baillon and J. Mueller, who, much as they differ in other respects, agreed in setting up the order *Buxaceæ*, taking their cue from Agardh, and making much of the dorsal rhaphe. Bentham concludes that this small group, however well defined, ought not in a general view to be regarded as of higher grade than one of the primary divisions, or tribes, of *Euphorbiaceæ*. We are not the less pleased with this that we quite expected it.

A wider interest will be felt in Mr. Bentham's *excursus* on nomenclature, or rather on some questions which the study of *Euphorbiaceæ* brought up, and which some recent discussions have made pertinent. The general laws of nomenclature of our day, and the principles on which they rest, are laid down in the code which was reported by Alphonse DeCandolle to the Paris International Convention, in the year 1867, and, being approved, was published with a commentary in the autumn of that year, and in an English translation early in the following year. The laws, without the commentary, were printed in this Journal for July, 1868. The ten years succeeding have tested, somewhat thoroughly, the questions (nearly all of minor moment) upon which differing usages prevailed; and though one or two points are still mooted, the great majority of phænogamous botanists are coming to be of one mind and practice. But, as Mr. Bentham remarks: "The result has not been quite effectual in checking the ever-increasing spread of confusion in synonymy. Besides the young liberal-minded botanists who scorn to submit to any rule but their own, there are others who differ materially in their interpretation of some of the laws, or who do not perceive that in following too strictly their letter instead of their spirit, they are only adding needlessly to the general disorder. In the application as well as in the interpretation of these rules they do not sufficiently bear in mind two general principles; first, that the object of the Linnæan nomenclature is the ready identification of species, genera, or other groups for study or reference, not the glorification of botanists; and secondly, that changing an established name is very different from giving a new name to a new plant."

It is to the latter point that this most experienced and even-minded botanist addresses himself. "The rule that long-established custom amounts to prescription, and may justify the maintenance of names which form exceptions to those laws which should be strictly adhered to in naming new plants, is unfortunately now frequently ignored. . . . . The law of priority is an excellent one; and when a genus or species has been well defined by an early botanist in a generally accessible work, but has subsequently been neglected, and the plant became known under other names, it is well that the original one should be restored. . . . . On the other hand, it creates nothing but confusion to suppress a generic name, well-characterized and universally adopted by long custom, in favor of a long-forgotten one, vaguely

designated in an obscure work, out of the reach of the great majority of botanists. . . . . The greater number of Necker's genera have been so imperfectly characterized, with so absurd a terminology, that they are quite indeterminable; and his names deserve to be absolutely ignored, except in the very few cases where Jussieu or other early French botanists have succeeded in identifying them, and corrected their characters; but even then it is doubtful whether these names should not bear the date of the correction, rather than of the original work. Adanson's "Familles," with all the inconveniences of its form and absurd orthography, is much more scientific, and many of his genera are well defined, and have therefore been properly adopted." . . . .

Let us here interject a practical application. There is an old and well-established genus *Smilacina* of Desfontaines. There is a much older genus *Tovaria* of Ruiz and Pavon, founded in 1794, ever since accepted, and without a synonym. Recently Mr. Baker of Kew, finding that Necker has a *Tovaria*, published in 1790, and therefore four years earlier than that of Ruiz and Pavon, takes up this name in place of *Smilacina*, and leaves a new name to be made for the long-established homonymous genus. It will be said that the rule of priority demands the sacrifice, and that the identification of Necker's genus is sure, because the three Linnæan species of *Convallaria* which properly constitute Desfontaines' *Smilacina* are referred to it by name; and that, though it be a case of *summum jus summa injuria*, the injurious consequence is a necessity. But Mr. Bentham's characterization of Necker's work applies even to this instance. Twice over Necker's *Tovaria* is described as having a perianth of five sepals, and the berry is said to be one-celled. Desfontaines' *Smilacina*, on the other hand, is correctly characterized. Moreover, if we do not include this among those names of Necker which, Mr. Bentham says, "deserve to be absolutely ignored," we may yet find that the law of priority has another claim on it. In 1763 a much better botanist than Necker, viz: Adanson, founded a genus *Tovara* (essentially the same name as *Tovaria*) on *Polygonum Virginianum* L., which is not unlikely to be taken up as a genus; and the name would supersede Necker's by the same rule that Necker's supersedes Desfontaines' *Smilacina*. All things considered, then, this is a case for the application of the homely but useful rule *Quieta non movere;* and much of Mr. Bentham's pertinent advice may be condensed into this maxim. But there remain nice questions to settle with regard to the names and extent of the liliaceous genus.

"The representing the Greek aspirate by an *h* was generally neglected by early botanists; but now, ever since DeCandolle altered *Elichrysum* into *Helichrysum*, modern purists have insisted upon inserting the *h* in all cases; and this has been so far acquiesced in that it is difficult now to object to it, though it has the effect of removing so many generic names to a distant part of all indexes, alphabetical catalogues, etc. Admitting the propriety of adding the aspirate in new names, I had long declined

to alter old names on this account; now, however, I find myself compelled to follow the current." Which is, on the whole, regretable, especially as Alph. DeCandolle would hold out with him. See the latter's comment on his Article 66, in which the remark is dropped that, "we do not see why we should be more rigorous than the Greeks themselves." Oddly enough, these same writers who must supply the aspirate to the *e* omit it from the *r*, and write *rachis* and *raphe*, instead of *rhachis* and *rhaphe*,—which is exasperating to lovers of uniformity.

It is unnecessary here to cite Mr. Bentham's appropriate illustration of the indivisibility of the two-worded name of a plant. The proper apprehension of this, and of the paramount rule that no *unnecessary* new names should be given to old plants, will go far to rid the science of a principal remaining ambiguity in nomenclature. For it clearly follows that when a plant has a rightful name under its proper genus, the specific half of it is not to be changed because of any earlier specific name under some other genus, to which the plant does not belong. A. G.

3. *Journal of a Tour in Marocco and the Great Atlas.* By Joseph Dalton Hooker, K.C.S.I., etc., and John Ball, F.R.S., etc. A brief notice of the geological appendix in this work is given on page 332. We add here a few words on the botanical results. Sir Joseph Hooker contributes an article on some of the economic plants; the most important portion of which relates to the Argan tree, the natural and economical history of which is now pretty well known. The narrative contains a wood-cut figure of a group of old Argan trees, in which goats are seen high up among the spreading branches, feeding upon the fruit. Of higher scientific interest is the comparison of the Canarian flora with the Maroccan (of which we cannot here undertake an abstract); also the comparison of the Atlas flora with that of the mountains of Grenada, and of northern Europe. So far as is yet known, the north European or Germanic character largely preponderates in it, yet absolutely without alpine representatives. These last probably exist, but at elevations which have not yet been reached. It was a trying experience to have surmounted a pass of the Great Atlas range, only to encounter a snow-storm, and to be obliged to turn back without reaching the higher crests so near at hand. Mr. Ball has worked up the botanical results technically and systematically in his *Spicilegium Floræ Maroccanæ*, which fills nearly 500 pages of the sixteenth volume of the Journal of the Linnean Society, and is illustrated by twenty plates. A. G.

4. *Eaton's Ferns of North America.*—We are not sure that we have noticed the later issues of this work, so important to all fern-people and botanists. But, in any case, we must make a note of Parts 12 and 13, a double number, which has just come to hand, the plates are so excellent. As to the letter-press, this is always satisfactory. *Aspidium acrostichoides* is well represented, and well colored. The same would be said of *Pteris aquilina*, were it not that the frond looks diminutive. The three *Asplenia* make a

fine plate. But the figure of *A. parvulum* is stiff: we never saw it growing bolt upright, and the difference in size between this and the other two is not made sufficiently manifest. A somewhat more northern range must be assigned to this species. We found it rather common in the mountains of the southern part of Virginia, as well as in North Carolina. *Adiantum Capillus-Veneris*, the subject of the next plate, and which is luxuriantly delineated, has just now come in from the same region in Virginia,—a discovery by Mr. Shriver. *A. emarginatum* would have been perfectly presented if the green were brighter and lucid. The three species of *Notholæna* make an admirable plate. A. G.

5. *Algæ Amer. Bor. Exsiccatæ;* by FARLOW, ANDERSON & EATON, *Fasc.* III.—The third Fasciculus of this distribution of North American Algæ has just been issued. It consists of only thirty specimens, covering twenty-nine species and one variety. But as most of the species are large plants, the paper used is of the folio size of most American herbariums. Twenty of the Algæ are of the black or olive-green series, and the other nine are Florideæ. Among the rarer kinds are *Sargassum pterpleuron*, from Florida, *Postelsia palmæformis*, *Pterygophora Californica*, *Dictyoneuron* and *Nereocystis*, from the Pacific Coast, and *Saccorhiza dermatodea*, from the coast of Maine. The Florideæ embrace several of the large *Gigartinas* of the Pacific shore, and three or four of those very puzzling forms of *Callophyllis*, which have so long been an unsolved riddle to the students of this class of plants. Dr. Farlow, who has done nearly all the work of identification, still hesitates to acknowledge the presence of the European *Callophyllis laciniata* on the coast of California; but then he has named two new species of the genus, No. 127, *C. furcata*, and No. 129, *C. gracilarioides.*

This is a very important publication, on account of the care, labor, expense, and critical investigation which are bestowed upon it, not to speak of the beauty and perfection of the specimens; and the associated authors should receive the best thanks of botanists. A. G.

6. *On the Black Mildew of Walls.*—Professor LEIDY remarked that in the number of "Hardwicke's Science Gossip" for August, presented this evening, there is an article by Professor Paley entitled, "Is the Blackness on St. Paul's merely the effect of Smoke?" According to the author, the blackness is mainly due to the growth of a hitherto undescribed lichen, which appears to flourish on limestone and in situations unaffected by the direct rays of the sun. Professor Leidy continued, that his attention had been called a number of years ago to a similar black appearance on the brick walls and granite work of houses in narrow shaded streets, especially in the vicinity of the Delaware River. Noticing a similar blackness on the bricks above the windows of a brewery, from which there was a constant escape of watery vapor, in a more central portion of the city, he was led to suspect that it was of a vegetable nature. On examination, the black

mildew proved to be an alga, closely allied to what he supposed to be the *Protococcus viridis*, which gives the bright green color to the trunks of trees, fences, and walls, mostly on the more shaded and northern side, everywhere in our vicinity. It probably may be the same plant in a different state, but, until proved to be so, may be distinguished by the name of *Protococcus lugubris*. It consists of minute round or oval cells, from 0·006 to 0·009^{mm} in diameter, isolated or in pairs or in groups of four, the result of division; or it occurs in short irregular chains of four or more cells up to a dozen, occasionally with a lateral offset of two or more cells. The cells by transmitted light appear of a brownish or olive-brownish hue. In mass to the naked eye the alga appears as an intensely black powder.—*Proc. Acad. Nat. Sci. Philad.*, Sept. 3, 1878.

7. *On two Bermuda fishes, mistakenly described as new;* by Dr. A. GÜNTHER.—In the February number of the Annals and Magazine of Natural History, pp. 150–151, is published a paper by Dr. A. Günther, F.R.S., "On two new Species of Fishes from the Bermudas." The species which he names *Gerres Jonesii*, was described by me in this Journal, vol. vii, August, 1874, p. 123, under the name *Diapterus Lefroyi;* that called by him *Belone Jonesii*, was also described by me, under the same name, and dedicated to the same worthy naturalist, in this Journal, vol. xiv, October, 1877, p. 295. The descriptions harmonize in all essential details, and I have myself seen the specimens which were subsequently presented by Mr. Jones to the British Museum, though my own descriptions were drawn up from other specimens collected by myself at nearly the same time and locality.

Smithsonian Institution, Feb. 17, 1879. G. BROWNE GOODE.

8. *Alaska Chitons and Limpets.*—A paper on this subject, by W. H. Dall, giving a synopsis of the genera and notes on the various species with their synonymy, makes a number of the Bulletin of the U. S. National Museum. It is illustrated by four plates, and some wood-cuts, representing the dentition of many of the species. The Bulletin is not yet separated into volumes, and this paper is No. 4 of Mr. Dall's "Scientific Results of the Exploration of Alaska," the first two numbers being in Proc. Philad. Acad., 1876.

IV. Miscellaneous Scientific Intelligence.

1. *On the discovery of mineral wax, Ozocerite, in Utah;* by Professor J. S. NEWBERRY. (From a letter to the Editors.)—I have obtained some of the recently discovered ozocerite in Salt Lake City from Professor J. E. Clayton, to whom also I am chiefly indebted for such information as I have in regard to its place and manner of occurrence. He writes me as follows: "The geographical position of the ozocerite deposits is in the Wahsatch Range, on the head waters of the Spanish Fork, east from the south end of Utah Lake. The material has been found saturating

beds of brown and bluish shales, probably of Tertiary age, and in masses of various dimensions more or less mingled with clay. These shales extend from the San Pete valley in a north-northeast direction for a distance of fifty or sixty miles, and the width of the area or basin which they occupy is at the middle point about twenty miles. The shale beds richest in paraffine vary in thickness from twenty to sixty feet, but there is no considerable accumulation of that substance on the surface, nor would this be possible, as it would be destroyed by the annual fires which sweep the country. I examined portions of this region two years ago for coal, and found in the oil shales a few thin seams, and saw the wax-like exudation in several places, but only in small quantity."

Other parties in Salt Lake informed me that the paraffine itself is sometimes twenty feet thick, and that the quantity is enormous; but Professor Clayton says that such statements are not authorized by any facts which have come under his observation.

In the above remarks I have called the earth wax of Utah ozocerite. As it has been stated to be zietrisikite, I may say that on my return from the west, my son and assistant, Spencer B. Newberry, made a series of careful experiments in my laboratory to determine its true nature, comparing it with the description of these hydrocarbons, and with authentic specimens which I have received directly from Galicia. He found that it had a melting point of 61·5° C., that it was completely soluble in a large volume of boiling ether, and that boiling alcohol extracted from it twenty per cent of a white, wax-like substance. It seems, therefore, to be certainly ozocerite and not zietrisikite; the latter melting at 90° C., and being insoluble in ether.

2. *The American Antiquarian: A Quarterly Journal* devoted to early American History, Ethnology and Archæology, edited by Rev. Stephen D. Peet. Cleveland, Ohio. (Brooks, Schinkel & Co.).—The third number of this new Journal was published in January, 1879; among other papers it contains one on native American Architecture, by E. A. Barber, which is illustrated by several figures of Colorado Cliff houses. The Journal is well edited and promises to be of value to all interested in Archæology.

3. *Wanderings in South America, the Northwest of the United States and the Antilles, in the years* 1812, 1816, 1820, 1824; by Charles Waterton, Esq. New edition, edited with biographical introduction and explanatory index, by the Rev. B. G. Wood. 520 pp. 8vo. London, 1879. (Macmillan & Co.).—The volume of "Waterton's Wanderings" was first published in 1825, and since that time it has afforded pleasure and profit to a large number of readers. In the present edition the original account is left unaltered, but to this are added a full and appreciative biography of the author, by the Rev. B. G. Wood, and a valuable Explanatory Index, covering 150 pages, in which information is given in regard to the many unusual animals, birds and trees, mentioned in the body of the work.

4. *A Real Telegraph.*—A new invention of a really practical character, not a mere "paulo post futurum" invention like many we have heard of lately, has just been made by Mr. E. A. Cowper, the well-known mechanical engineer. It is a real telegraphic writing machine. The writer in London moves his pen, and simultaneously at Brighton another pen is moved, as though by a phantom hand, in precisely similar curves and motions. The writer writes in London, the ink marks in Brighton. We have seen this instrument at work, and its marvels are quite as startling as those of the telephone. The pen at the receiving end has all the appearance of being guided by a spirit hand. The apparatus is shortly to be made public before the Society of Telegraph Engineers.—*Nature*, Feb. 6.

5. *The chemical composition and physical properties of Steel Rails.*—Dr. C. B. DUDLEY, Chemist of the Pennsylvania Railroad Company, has made an extended investigation of the relation between the chemical composition of steel rails and their power to withstand wear, and in view of the great practical importance of the subject his results cannot fail to have a high value. Some of his conclusions are:—that high phosphorus is inconsistent with safety; that the silicon should be as low as is consistent with the successful working of the Bessemer process; that the best range of carbon is 0·25 to 0·35 per cent, and of manganese from 0·30 to 0·40 per cent. He also concludes that the wearing power of steel rails does necessarily increase with their greater hardness.—(*Trans. Inst. Min. Engineers*, vol. vii.)

6. *The Meteorologist*, published monthly in the interest of the Science of Meteorology. Vol. i, No. 1, March, 1879, J. M. L. STUMP, editor, Greensburg, Pa. An eight-page journal devoted to meteorology.

7. *The Paleontologist.* No. 3, Jan. 15, 1879, Cincinnati. Contains description of new species of fossils from the Lower and Upper Silurian rocks of Ohio, by U. P. James.

OBITUARY.

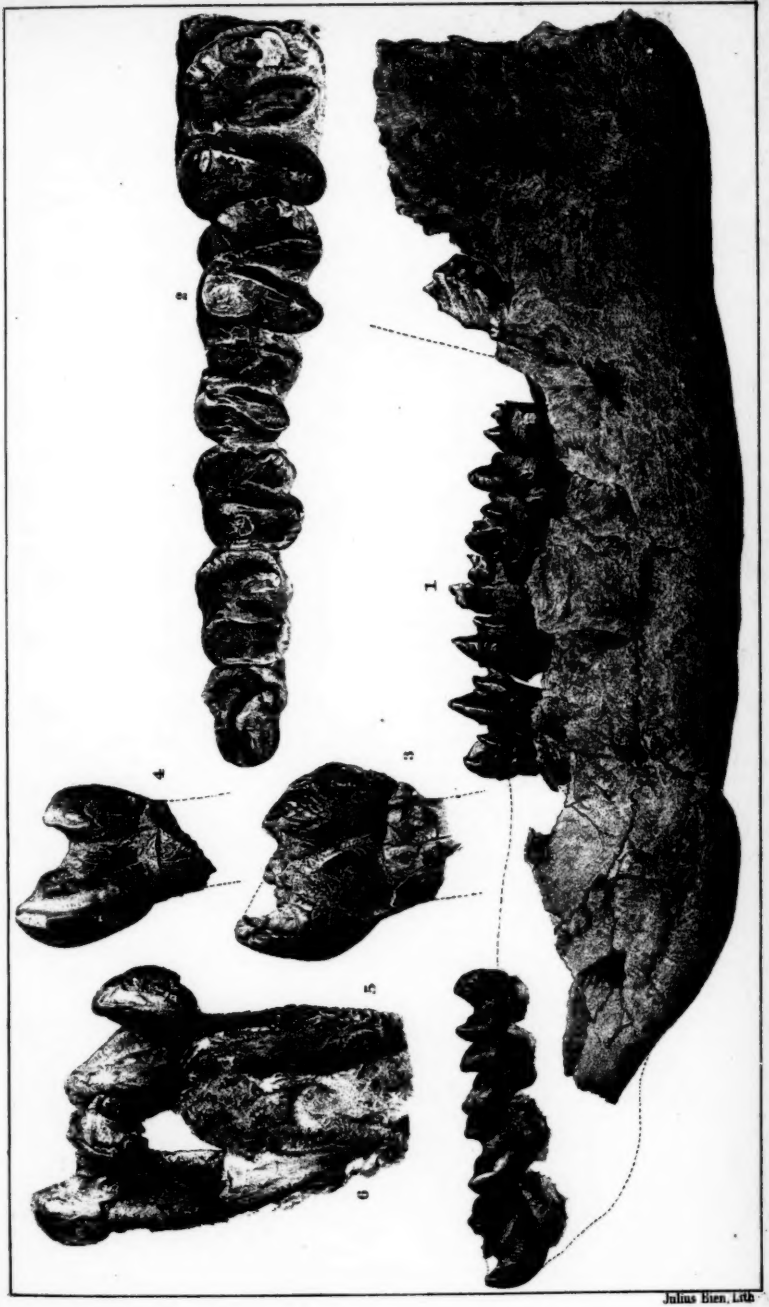
Professor GUSTAV LEONHARD, of Heidelberg, died December 27, 1878. He was well known as the author of works on Mineralogy and Geognosy, and as editor with Professer H. B. Geinitz, of the Neues Jahrbuch für Mineralogie, Geologie und Paleontologie.

On the extent and significance of the Wisconsin Kettle Moraine, by T. C. Chamberlain, A.M., State Geologist and Professor of Geology in Beloit College (Trans. Wisc. Academy of Sciences.)

On the Annelida Chætopoda of the Virginian Coast, by H. E. Webster (Transactions of the Albany Institute, vol. ix, January, 1879.)

Apuntes relativos à los Huracanes de las Antillas en Septiembre y Octubre de 1875 y 1876; Discurso leido en la real Academia de Ciencias Medicas, Fisicas y Naturales de la Habana en Sesion del 9 de Septiembre de 1877 y siguientes; par el socio de merito Rdo, P. Benito Viñes, S. J., Director del Observatorio. 25 pp. 8vo. Havana, 1878.

The Local Geology of Davenport, Iowa; by Rev. W. H. Barris (Davenport Academy Natural Sciences, Sept., 1876). New Fossils from the Corniferous Formation at Davenport (ibid., Oct., 1878).



Julius Bien, Lith.